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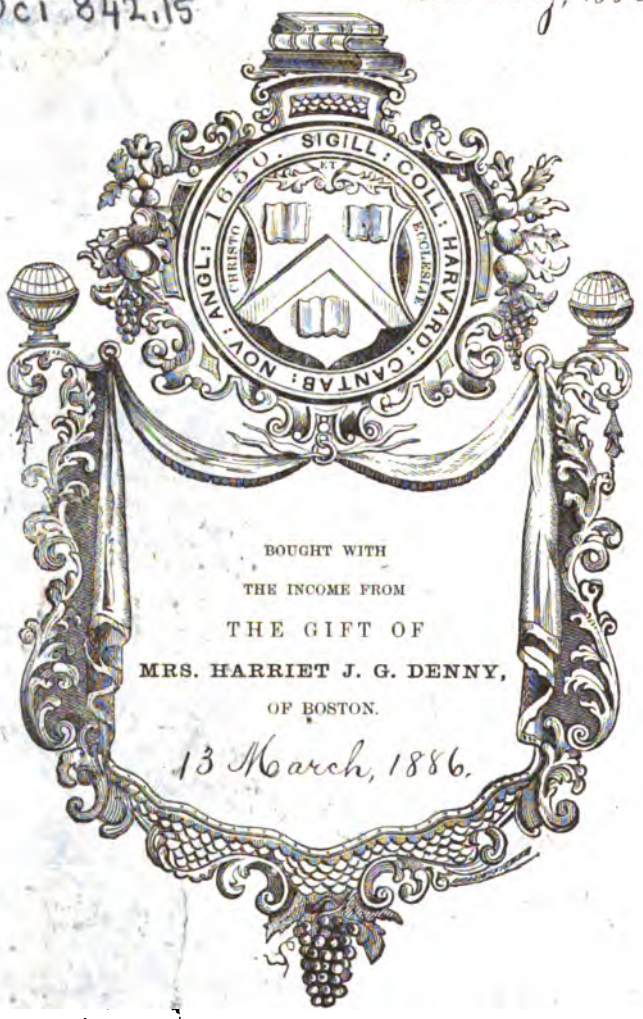

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PART I.

PROCEEDINGS

OF THE

METEOROLOGICAL CONFERENCE

AT LEIPZIG.

PROTOCOLS AND APPENDICES

FORMING THE FIRST OFFICIAL REPORT: APPENDICES

No. II. OF THE ZEITSCHRIFT FÜR METEOROLOGIE

Published by the Authority of the Meteorological

LONDON:

PRINTED BY GEORGE E. EYRE AND WILLIAM SPOTTISWOODE

PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.

FOR HER MAJESTY'S STATIONERY OFFICE.

SOLD BY E. STANFORD, CHARING CROSS.

1873.

Price One Shilling.

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Non-Official No. 6.

REPORT

OF

THE PROCEEDINGS

OF THE

INTERNATIONAL METEOROLOGICAL CONFERENCE AT LEIPZIG,

PROTOCOLS AND APPENDICES.

TRANSLATED FROM THE OFFICIAL REPORT, APPENDIX TO VOL. VII., No. 24, OF THE ZEITSCHRIFT FÜR METEOROLOGIE.

Published by the Authority of the Meteorological Committee.

LONDON:
PRINTED BY GEORGE E. EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.
FOR HER MAJESTY'S STATIONERY OFFICE.
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INTRODUCTION.

GENTLEMEN,

HAVING received instructions from you on the 1st of July to attend the Conference of Meteorologists at Leipzig in the month of August, I beg to report that your instructions have been carried out, and I herewith submit to you a complete English translation of the Proceedings of the Conference, as published officially as an Appendix to the Journal of the Austrian Meteorological Society.

I have prefixed to the Report a translation of the Invitation, which appeared in the same Journal in the month of June last.

Your obedient servant,
ROBERT H. SCOTT.

To the Meteorological Committee
of the Royal Society.

Dec. 16th, 1872.

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INVITATION

TO A

Meeting of Meteorologists to be held in Leipzig in August of this Year.

THE development of interest in meteorological investigations in modern times among all civilized nations has brought into prominence a requirement which has been long felt, and to which utterance has often been given,* viz. that of greater uniformity of procedure in different countries. The undersigned accordingly venture to hope for general approval, if they allow themselves to make a few proposals which may tend to smooth the way for the ultimate assembling of an actual Meteorological Congress.

If there be any branch of science in which work on a uniform system can be especially useful and advantageous, that branch is the inquiry into the laws of weather, which, from its very nature, can only be prosecuted with a hope of success by means of very extensive observations embracing large areas, in fact, we might almost say, extending over the whole surface of the globe. Owing to the enormous amount of material with which the meteorologist has to deal, the necessity for improved facilities for summarizing facts is daily more and more felt, and these can only be afforded by increased uniformity in the methods of observation and publication.

Among the other results of the increasing interest in Meteorology of late years has been the introduction of new instruments and new methods of observation, the practicability of which, as well as the possibility of their general introduction into use, can only be determined by combined action.

It may furthermore be safely assumed that a personal inter-

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* Recently by Buys Ballot, in a special pamphlet, "Suggestions on a Uniform System of Meteorological Observations," Utrecht, 1872.

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change of ideas among meteorologists will give an entirely fresh impulse to many branches of Meteorology.

It is only by means of an International Congress that speedy and certain methods of exchange of meteorological publications can be arranged—a step most urgently demanded, owing to the very nature of the science.

We think, however, that, without wishing in any way to anticipate the deliberations of the present meeting, it will be advisable, in order to fix ideas, to propose a certain number of questions which, in our opinion, may be proposed for discussion and possibly be answered.

1. Is it desirable to introduce the same Units of Measure (viz. of Length, Degrees, and Time) in meteorological inquiries in all countries, or is it sufficient to lay down certain fixed rules for the conversion of the different measures employed in the several countries?
2. What is the best form of Barometers for stations of the second order? Is the use of Aneroids for such stations admissible.
3. What mode of exposure of Thermometers for the observation of Air Temperature is the best and most suitable for general adoption?
4. What is the best construction of Maximum and Minimum Thermometers?
5. What instruments should be employed for determining the intensity of Radiation, and in what way can the comparability of the results obtained be ensured?
6. What instruments are the best for determining Earth Temperatures? At what depths should the observations be taken in order to attain the uniformity which is desirable?
7. What apparatus should be employed for the determination of the Hygrometric condition of the air? Are the Wet and Dry Bulb Thermometers sufficient? Can the Hair Hygrometer be employed, and under what restrictions?
8. In what way can uniformity in describing the Directions of the Wind be attained?

   Is the deduction of the mean Direction of the Wind by Lambert's formula desirable?

   Is it desirable or not to include very light winds (force 0) in constructing Wind Roses for the Direction of the Wind?
9. What scale should be employed for the Force of the Wind when it is determined, not by actual measurement, but only by estimation?

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10. Is it desirable to introduce simple counting instruments for determining the Velocity of the Wind? What units should be taken for the discussion of the Velocity of the Wind?
11. What is the best form, size, and mode of exposure of Rain-gauges?
    At what hour of the day should the fall be measured?
12. Should the days of Rain and Snow be counted separately or together?
13. Is it desirable in giving the falls of Hail to draw a distinction between "Graupel"* and true Hail?
14. In counting Thunderstorms, should the Storms as such or the Days of storm be given? In what way should the instances of Sheet-lightning be noticed?
15. What apparatus is to be recommended for the measurement of Evaporation? What is the most suitable exposure for the Vaporimeter?
16. In what way should the proportion of Cloud in the sky be estimated and indicated?
    Is it desirable to introduce for Clouds, Hydrometeors, and for other extraordinary phenomena, a nomenclature which shall be independent of local language, and therefore universally intelligible?
17. Should other Meteorological Elements than those already enumerated, *e.g.* Atmospheric Electricity, &c., be included in the scope of normal observations, and what are the best instruments for observing them?
18. Can uniform Times of Observation be introduced for the normal observations?
19. Can rules universally applicable be laid down for the Verification of Instruments and the Inspection of Meteorological Stations?
20. What are the rules and what the intervals of time for which the Means of the several Meteorological Elements should be calculated? Which is the better plan, to begin the meteorological year with December or with January?
21. In what manner and for what intervals are the Normal Values for the individual Meteorological Elements to be deduced?
22. Is it desirable and possible to publish the Meteorological Observations of a limited number of stations in each country

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* There is no special term for "Graupel" in English: it differs from Hail, in that the stones are small pellets of snow, and are not coated with ice.—TRANS.

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in a uniform manner, and within a reasonably short time after the observations have been made?

23. How is the Exchange of the Meteorological Publications of different Institutions and different Countries to be carried out most speedily, safely, and simply?
24. Is it desirable that in each country there should be established one or more Central Institutions for the direction, collection, and publication of the Meteorological Observations?
25. Does the interchange of Weather Telegrams appear so useful that it should receive a fuller development and a firmer organization?
26. What Regulations should be adopted in order to carry into effect the Decisions and the Objects of the Meteorological Congress?

The enumeration of the preceding questions, the discussion of which will lead to other subjects for deliberation of the same character, should be sufficient to show the importance of the points which remain for settlement by an International Meteorological Congress, and we accordingly deem that we shall not be far astray if we count on the co-operation not only of all Meteorologists by profession, but also of Learned Societies, and, as an ultimate consequence, of Governments also, with regard to the realization of the idea of such a Congress and its practical efficiency.

We are of opinion that the actual Congress should be summoned for the autumn of 1873 and for Vienna. There are two reasons for selecting that city. Firstly, a new Central Meteorological and Magnetical Institute has been built, and will be fitted out with new instruments and in full activity next year; and, secondly, the International Exhibition, which will be open at the time, will form an additional inducement to foreign scientific men to visit Vienna.

For the present year we think it advisable to hold a preliminary Conference of meteorologists; of course this Conference can only be *consultative;* its chief duty will be to lay down the programme for the actual Congress, perhaps to instigate preparatory experiments on the questions proposed, and thereby to render it possible for the Congress to arrive at immediate conclusions on many points.

We venture by the present circular to invite the heads of Meteorological Institutes, the Meteorological and other Learned Societies, as well as private scientific men and practical observers in the domain of Meteorology, to this consultative meeting, which

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is to be held in Leipzig at the time of the meeting of the Naturforscher Versammlung in that city. The gentlemen who are willing to take part in this meeting are requested to intimate their intentions at latest by the 13th of August to the undersigned Director of the University Observatory in Leipzig, Dr. Carl Bruhns. The commencement of the Conference is fixed for the 14th of August, and it is probable that the proceedings will last from the 14th to the 16th of August (inclusive).

All heads of Meteorological Institutes who do not take part in this consultative meeting, as well as the Meteorological and other Learned Societies which are not represented at it, are requested, in the interest of the cause, at least to communicate, by letter, their views and wishes in respect of the measures which should be adopted to ensure the uniformity which is desired, in order that the object may be attained with greater certainty by a combined effort, in which all take part.

(Signed) Dr. C. Bruhns.

Leipzig, May 1872.

(Signed) Dr. H. Wild.

St. Petersburg, May $\frac{15}{27}$, 1872.

(Signed) Dr. C. Jelinek.

Vienna, June 2, 1872.

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List of Persons present at the Meteorological Conference at Leipzig.

1. H. Abich - - - Imperial Russian Staatsrath, Tiflis.
2. — Beez - - - Professor, Realschule, Plauen.
3. Dr. F. Behrens - - Privatdocent, University, Kiel.
4. Dr. G. v. Boguslawski - Stettin.
5. Dr. C. Bruhns - - Director of the Observatory, Leipzig.
6. A. Buchan - - Secretary, Scottish Meteorological Society, Edinburgh.
7. Dr. H. Buff - - Professor, University, Giessen.
8. Dr. Buys Ballot - - Director of the Royal Meteorological Institute, Utrecht.
9. Dr. P. Carl - - Professor, Munich.
10. Dr. E. Dreisch - - Halberstadt.
11. Dr. Ebermayer - - Professor, Aschaffenburg.
12. Dr. Feddersen - - Physicist, Leipzig.
13. W. H. v. Freeden - - Director of the Norddeutsche Seewarte, Hamburg.
14. L. Friedrichsen - - Cartographer, Hamburg.
15. Dr. Galle - - - Director of the Observatory, Breslau.
16. Dr. Hankel - - Professor, University, Leipzig.
17. Dr. J. Hann - - Assistant, Meteorological Central-Anstalt, Vienna.
18. Dr. Hänsel - - Professor, Realschule, Chemnitz.
19. Dr. C. Jelinek - - Director of the Meteorological Central-Anstalt, Vienna.
20. Dr. G. Karsten - - Professor, University, Kiel.
21. Dr. A. Krueger - - Director of the Observatory, Helsingfors.
22. H. Leppig - - Assistant, Observatory, Leipzig.
23. Dr. Lindemann - - Professor, Gymnasium, Annaberg.
24. Dr. E. Lösche - - Professor, Polytechnic School, Dresden.
25. — Mackendrick - - Edinburgh.
26. Dr. Meyerstein - - Göttingen.
27. G. J. Milne - - Edinburgh.
28. Dr. H. Möhl - - Professor, Gewerberschule, Cassel.
29. C. Moesta, Dresden - Late Director of the Observatory, Santiago, Chili.
30. R. Müller - - - Director of the Hydrographic Office, Pola.
31. G. Neumayer - - Hydrographer of the Admiralty, Berlin.
32. A. v. Oettingen - - Professor, University, Dorpat.
33. Dr. L. Pfeiffer - - Surgeon, Weimar.
34. Dr. M. A. F. Prestel - Professor, Emden.
35. D. Ragona - - Director of the Royal Observatory, Modena.
36. Dr. F. Ratzel - - Munich.
37. Dr. R. Rühlmann - - Professor, Gymnasium, Chemnitz.
38. Dr. G. Schenzl - - Director of the Meteorological Central Anstalt, Pesth.
39. C. Schildbach - - Physician, Leipzig.
40. Dr. H. Schoder - - Professor, Polytechnic School, Stuttgard.
41. Dr. P. H. Schreiber - Assistant, Gewerbeschule, Chemnitz.
42. R. H. Scott - - Director of the Meteorological Office, London.
43. Dr. E. H. Sell - - New York.
44. Dr. Selling - - Würzburg.
45. L. Sohnke - - Professor, Polytechnic School, Carlshruhe.
46. Baron O. v. Sternbach - Bludenz.
47. A. F. Sundell - - Physicist, Helsingfors.
48. Dr. O. Ule - - Editor of "Nature," Halle.
49. D. H. Weber - - Privatdocent, in Physics, Berlin.
50. H. Wild - - - Director of the Central Physical Observatory, St. Petersburg.
51. Dr. Wittwer - - Professor, Ratisbon.
52. Dr. J. Ziegler - - Frankfort-on-the-Maine.

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PROCEEDINGS

OF THE

METEOROLOGICAL CONFERENCE AT LEIPZIG.

Protocol of the Meeting, 14th August, 12 to 4 o'clock, p.m.

M. BRUHNS opened the Conference and welcomed it in the name of the Saxon Government. Upon this M. D. RAGONA from Modena rose, and in the name of his countrymen expressed the wish that an international agreement on meteorological questions should be arrived at.

On M. BRUHNS' proposal the Conference chose M. BUYS BALLOT as President for this day; for the next two days Mr. SCOTT and M. WILD; for Vice-Presidents for the three days MM. BRUHNS, JELINEK, and WILD; as Secretaries, M. NEUMAYER of Berlin, and M. HANN of Vienna.

M. BRUHNS read the written replies, received to the questions proposed in the programme which had been distributed, from MM. Dove of Berlin, Mohn of Christiania, Wolf of Zurich, Hoffmeyer of Copenhagen, Pujazon of San Fernando, Fradesso da Silveira of Lisbon, Fritsch of Salzburg, Rubenson of Upsala, and Symons of London. And written expressions of sympathy had also been received from MM. Lauterburg of Berne, Heis of Münster, and Moritz of Tiflis.

M. BUYS BALLOT then opened the discussion of the programme and remarked that it was of great interest to have received in writing the opinion of some of the most eminent men in meteorological science.

The next point decided was as to the commencement and duration of the sittings. It was decided that they were to last from 12 till 4 o'clock, without interruption, and the meeting then proceeded to discuss the questions laid before it.

1. Is it desirable to introduce the same Units of Measure (viz. of Length, Degrees, and Time) in meteorological inquiries in all countries, or is it sufficient to lay down certain fixed rules for the conversion of the different measures employed in the several countries?

M. BRUHNS first remarked that it would be best to postpone the discussion of this question until they had received the result of the deliberation of the Metric Conference in Paris.

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Uniformity of scales.

Mr. SCOTT thought that the Conference would lose time by this discussion of a subject which really could only be arranged by Governments.

Mr. BUCHAN expressed himself in favour of the introduction of the metric scale. He thought that an energetical recommendation of the metric scale on the part of this Conference would produce a good impression on the British Government. The matter was certainly important, but it ought not to be made a vital question. The general introduction of the metric scale had at present difficulties to meet with, and therefore this Conference should, for the present, content itself with recommending the publication of Tables for the Conversion of Scales, especially for Rain and Wind Velocity, and should recommend a system uniform in all respects; especially a recommendation should be made to Norway and Sweden to reduce their measures for rain, which are unknown to foreigners. He remarked that it should not proceed further than a recommendation.

Mr. SCOTT remarked that, as far as he knew, England was less inclined to adopt the metric scale now than formerly.

M. PRESTEL said that the scientific world had now arrived at a turning point in meteorology; the dynamical treatment of it had hardly begun. He recommended the general introduction of the metric scale, as being the only one which offers the great advantage of simple relations between the linear and cubic units of volume and weight. If it be wished to represent the changes of the weather in their causal relationship, and especially to submit to calculation the part which Aqueous Vapour plays in the atmosphere, no other scale is possible.

M. BUYS BALLOT expressed himself fully satisfied with Mr. Buchan's observations. The mutual conversion of the individual scales could still be effected and the practice in Meteorology might be the same as in Statistics, viz., that one unit of scale be chosen for the means; the original scale being preserved for the individual observations. He had for twenty years past reduced, for his Jaarboek, the most different scales to the metric scales without very great labour.

M. BRUHNS recommended that this expression of opinion should be published as such, and that the wish should be appended, that, according to M. Buys Ballot's proposal, the Results of observations, or the Means, should be published in metric scales, in addition to their original scales.

This proposal was accepted by the meeting.

Mr. SCOTT further drew attention to one advantage possessed by the Fahrenheit scale for Weather Telegraphy. The degrees are so small that it is only necessary to telegraph whole numbers, without materially interfering with the accuracy of hygrometrical determinations.

He thought that M. Mohn, although he had not so expressed himself in his letter, would agree with him on this point.

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2. What is the best form of Barometers for stations of the second order? Is the use of Aneroids for such stations admissible? Barometers.

M. Buys Ballot thought there was hardly anyone who would declare himself in favour of the Aneroid for scientific purposes.

M. Prestel expressed a wish that the value of Aneroids for scientific observations should be discussed.

M. Jelinek recommended, for normal stations, Mercurial Barometers of the most careful construction, but thought that for stations of the second order, the Aneroid was not a bad instrument for the determination of differences in pressure, and it could also be of value on shipboard, as the usual marine barometer was too sluggish. The various defects of Aneroid Barometers may be fairly contrasted with certain difficulties in the handling and the suspension of Mercurial Barometers.

M. Ragona remarked that Aneroids bore carriage badly, and that therefore the comparison of them with Standard Barometers was unsatisfactory.

Mr. Buchan agreed with M. Jelinek's views. Aneroids might be employed for the comparison of Mercurial Barometers *for very short intervals of time*, as *e.g.* on the inspections of stations, and on board ship; without doubt perfect confidence could not be placed on these instruments, but occasionally Mercurial Barometers too get out of order. As it is easy to transport aneroids in order to compare them with other barometers and with each other, they should not be taken out of the hands of meteorologists.

M. Bruhns said that aneroids could not be accepted as scientific instruments, but might often serve for a control, *e.g.*, in case of errors of observation being made with mercurial barometers, &c. He wished that the questions should be referred to a committee.

Mr. Scott remarked that when we compare the two statements that the Aneroid is not a scientific instrument, but is an instrument for controlling others, we have a contradiction in terms. The Aneroid is an instrument whose corrections are constantly changing, and therefore cannot be used at all.

M. von Freeden agreed with the last speaker. Aneroids which give good readings at the mean value of pressure do not follow the great barometrical oscillations; in such a case they undergo permanent alteration in their corrections.

M. Wild: Aneroids should not be entirely rejected. They are at least good as interpolation and difference instruments, to supply gaps in observations which may always occur if the Mercurial Barometer is damaged.

M. Müller expressed himself against the use of Aneroids.

Mr. Scott remarked that the more costly Aneroids with thermometers were even less useful than those without thermometers, inasmuch as in certain cases of injury, the quicksilver of the thermometer destroys the whole instrument.

M. Ragona observed that stations of the second order might

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Barometers.

very well be provided with instruments of that construction, and, although it was not perfectly satisfactory as a regular observing instrument, it could very well be used for occasional interpolations.

The PRESIDENT, M. BUYS BALLOT, summarised the result of the deliberations on the utility of the Aneroid to the following intent:—that the Aneroid should not be used *instead* of the Mercurial Barometer, but only as an interpolation instrument, *in addition* thereto.

M. BRUHNS proposed that the second point in the question under discussion; respecting the construction of a Barometer suitable for stations of the second order; should be referred to a committee, and suggested MM. JELINEK, HANN, and BUCHAN as members of it.

M. von OETTINGEN thought the matter too important to hand it simply over to a committee, and thought a decision should be come to at the present meeting; while M. WILD remarked that the appointment of a committee whose members lived in different countries was a bad arrangement.

Finally, M. HANN was requested to undertake alone the duty of reporting on this question, and to put himself in communication on the subject with foreign authorities.

Exposure of thermometers.

3. What mode of exposure of Thermometers for the observation of Air Temperature is the best and most suitable for general adoption?

M. RAGONA expressed himself against the enclosure of thermometers in a screen, and thought that readings taken outside a window were good and might well be adopted in case of the observers' employing a telescope for reading, as he always did.

M. BRUHNS requested Messrs. Scott and Buchan to give their opinions on the subject.

Mr. BUCHAN held the question as one of the greatest importance for the determination of temperature, because it included also that of the height of the thermometers above the ground. He thought that all the experience which had been gained on the subject hitherto had not as yet led to positive conclusions, but that a committee should be nominated to decide on the height of the thermometers, the size of the screens, and the necessary circulation of the air, so that it should be in a position to make definite proposals at the Meteorological Congress at Vienna next year.* In Scotland they used Stevenson's mode of exposure in a wooden box, four feet above the ground, and the soil below must be covered with grass.

Mr. SCOTT explained the construction of Stevenson's screen, and drew attention to some of the difficulties which are met with in the exact determination of air-temperature, the causes of which

* Correction in English edition. For "decide on"—"next year," read "collect "statistics from institutions and observatories, relative to the height of the ther- "mometers above the ground, and the methods by which they are protected, and "prepare a report for the Meteorological Congress at Vienna, as a basis for discussion "of the whole subject."—A. BUCHAN.

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are to be found in the fact that local conditions are of too great importance. It is especially difficult to give proper protection against radiation. The Scotch screens are good, but heavy snow produces inconvenience. On the other hand, in his opinion, Glaisher's screen was as good as useless. He thought that Mr. Buchan's proposal could hardly be adopted, and finally drew attention to a long series of observations by Mr. Griffith which embraced 20* modes of exposure, the observations being repeated several times daily, and of which the results might soon be expected to be published. Exposure of thermometers.

M. BRUHNS made the proposal that, at the central observatories, experiments should be made with various modes of exposure of the thermometers, but it was in the first instance most desirable that the several directors of organizations who were present should explain to the meeting the various modes of exposure at present adopted.

M. WILD first complied with this request, and explained the Swiss mode of exposure of thermometers, behind double cylinders of sheet-iron, pierced with holes, and with a louvred roof. But in this form they must not be brought too near heated walls, and must not be exposed to the sun; therefore in Russia they enclosed them with a double wooden envelope, because in winter care must be taken to guard against the influence of the walls of houses which are strongly heated from inside, and in summer against the sun's rays which strike on the north walls. Differences of temperature, to the extent of a degree, are found between sheet-iron screens so protected and those placed freely before heated walls.

M. JELINEK explained the exposure of thermometers in Austria. Although it is very desirable to give up the exposure immediately before windows, some attention must still be paid to the convenience of the observers, especially in the districts where the observers are volunteers, and undertake observations without pay. He further drew attention to the rotation thermometer (thermomètre fronde) recommended by M. Renou, which is to serve for the determination of the true temperature of the air.

M. von OETTINGEN remarked that in northern countries it was simply impossible to give up the exposure at windows. He said that it would be very difficult to introduce that which was theoretically the best, because so much depended on the good will of the observers.

M. EBERMAYER stated that his Government had put him in a position, by giving necessary funds, to carry out strictly the demands of science in regard to the method of observations, a circumstance which was attended with special difficulties in his case, because he had to deal with the determination of the temperature in forests and on high trees. He could not but draw special attention to the fact that complete trustworthiness of observations could only be guaranteed by State support.

M. von FREEDEN had at first tried the Scotch screen, but med-

* Correction in English Edition. The real number is 10, not 20.—R. H. SCOTT.

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Exposure of thermometers.

dling hands had constantly interfered with this mode of observation. Now, his thermometers are placed in a louvred screen on the south side of his house, in deep shade. The readings are taken from inside the house. Frequent check-observations made with thermometers placed so as to face the north, on the Prussian system, had confirmed the satisfactoriness of his method of observation.

M. RAGONA sketched the plan adopted by him, in which the thermometer is placed in an aperture made in a thick wall, which is closed on the inside by a window and has a pent-house roof over it on the outside. It is read with a telescope.

M. BRUHNS explained the mode of exposure before a window adopted in Saxony. This is, at the best stations, on the north side, generally between double walls or louvres. But at the forest stations the psychrometers often face east and west, and are read there while the sun is not shining on them. Care is also taken that the thermometer is placed before a room which is not heated, and at 1½ foot from the wall. At the observatory he had made observations at various heights above the ground, and great daily differences were found, while the yearly and monthly means agreed. He proposed, in order to investigate the question, to refer it to a committee consisting of Messrs. Scott, Buchan, and Wild.

M. BUYS BALLOT drew attention to the necessity of free circulation of air in the screen.

M. RÜHLMANN described his experiments to introduce his thermometers into a constant current of air, of moderate force, kept up by an aspirator. By such means the true temperature might be determined as accurately as possible.

Baron von STERNBACH spoke in favour of the mode of exposure of thermometers usually adopted in Austria. The usual interval between the thermometers and the wall, suppose 3 feet, excluded the influence of the latter. In this way he had found the same temperature on all sides of his house.

Messrs. WILD and SCOTT declared themselves ready to test some modes of exposure, but the latter drew attention to the fact that the Scotch method determined the temperature at a height of 4 feet, the Prussian at 12 feet, so that an immediate comparison of the result was impossible.

M. WILD remarked that the experiments might be made at the same heights, but with different screens.

M. BRUHNS proposed to test the Scotch, Russian, and German modes of exposure at the heights of 8 and 20 feet for the purpose of comparison.

Mr. SCOTT remarked that he hoped to be able to have an opportunity of carrying on experiments at Kew up to a height of 120 feet.

M. WILD declared himself ready to carry on experiments at different heights, and stated that at Pulkowa such observations had already been made on the ground, and up to the height of 70 feet.

M. von OETTINGEN stated his conviction that it would be

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impossible to introduce the same mode of exposure at all stations, but he thought that it would be possible in the way suggested to reduce the observations to similar heights. Exposure of thermometers.

M. von FREEDEN said he could have observations taken up to the height of 100 feet; he wished to be allowed to make the observations, at the upper station, only at 10 and 4 o'clock.

M. BRUHNS wished to suggest to MM. Jelinek and Prestel similar observations.

M. JELINEK was afraid that these experiments would not lead to the results that were desired, for with respect to the observations which had been instituted on a uniform plan by M. Prestel in Emden and M. Fritsch in Vienna, the results had been discordant, so that there was fear of failure in this case too. The influence of the different localities to which the experiments must be adapted, exercises a disturbing effect on the results of the observations. Virtually the subject to be investigated should be the influence of various heights on thermometers attached to a pole erected at a distance from any houses.

M. PRESTEL explained his method of determining temperature at various heights and communicated the results, remarking that the thermometers which had been employed had been exposed freely and without screens. The temperature increased with the height, and most rapidly on days of thunderstorms. At that time the highest and lowest thermometers showed differences as great as 5°. Furthermore the increase was considerable with S.E. winds, but almost *nil* with N.W.

M. BUYS BALLOT limited the question proposed in so far as the only matter was to determine local temperature correctly, and therefore the observer had always to give the height of his thermometers and adhere to it. He referred to his "Suggestions," p. 14.

The Conference then declared itself satisfied that MM. SCOTT, WILD, JELINEK, and PRESTEL should undertake the investigation of the various modes of exposure, and the debate on this subject was closed.

4. What is the best construction of Maximum and Minimum Thermometers? Maximum and minimum thermometers.

M. WILD communicated the result of his experience on the value of the maximum thermometer. Of all maximum thermometers which are in use there is not one which is really of value, at least not for stations. All get out of order, even Geissler's, which, in other respects are the best. Metallic thermometers are pretty good if often cleaned. The minimum thermometer, for which, without hesitation, a spirit thermometer may be adopted, is better and is also of greater importance, and therefore he recommended its use.

M. MÖHL uses the maximum thermometer with two glass rods of different colours laid one behind the other.

M. EBERMAYER had gained the experience that in this appa-

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Maximum and minimum thermometers.

ratus one of the rods dips in the quicksilver, and he recommended a maximum thermometer prepared by Greiner in Munich, which has proved permanently satisfactory.

M. BRUHNS finds that none of the maximum thermometers can be trusted to remain in order. It is only the minimum thermometer which never fails in action.

Mr. SCOTT recommended in general Negretti and Zambra's maximum, and, on inquiry, he stated the price of this instrument was about a guinea. Casella's minimum thermometer with mercury as thermometric liquid is very beautifully finished, but its action is not quite trustworthy.

M. BUYS BALLOT remarked that he had got favourable experience of these thermometers.

M. von FREEDEN drew attention to the fact that, for each of these instruments, the proper slope must first be discovered by trial, in order that it may perform regularly; a remark which was confirmed by M. BEHRENS who had compared several at various temperatures at Kiel for Professor Karsten.

Several members of the Conference remarked that a serious objection to the spirit thermometer was found in the fact that the spirit evaporated and condensed in the upper end of the tube.

M. EBERMAYER stated that this objection could be removed if the tube were, at its entrance into the bulb, inserted nearly up to the inner side of the bulb, as Greiner in Munich did when requested. According to his experience this arrangement entirely removed the objection which had been mentioned.

The President then gave a resumé of the discussion on Question 4, the general tendency of which was that the performance of the minimum thermometer was satisfactory, but that of the maximum not so to such a degree that a uniform construction of it could be generally recommended. The meeting then expressed their opinion that it would be very desirable to devise trustworthy maximum thermometers. It further expressed the opinion that the reading of the thermometric liquid in maximum and minimum thermometers should be constantly compared with ordinary thermometers, in order to be able to determine the corrections (which are changeable in the case of spirit thermometers).

The second sitting was fixed for 12 o'clock next day. Mr. SCOTT was chosen as President, and M. WILD as Vice-President. The first sitting closed at 4 o'clock.

2. Protocol of the Sitting of the 15th of August.

Mr. SCOTT, as President, opened the meeting with a few official communications, and presented to the Conference some new publications of the British Meteorological Office. Two letters had been received from M. Hildebrandsson, of Upsala, and M. Estreber, director of the Statistical Office at Costa Rica, at present in Berlin.

M. NEUMAYER made the following proposal: Inasmuch as, according to the course of the proceedings hitherto, and the brevity

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of the time which is still available, it will be hardly possible to take up for discussion the immediate interests of Maritime Meteorology at the Conference, a committee had better be at once nominated, in order to prepare a proposal for the next day's meeting, which, if adopted by the Conference, might be embodied in its Proceedings. M. NEUMAYER spoke at some length in favour of his proposal, and pointed out especially that, since the Brussels' Congress, nothing more had been done with a tendency to to establish uniformity in meteorological observations at sea. It was also especially advisable to come to an agreement about the division of labour, by which a prodigious saving of labour might be effected. The proposal was supported and accepted, and the following members of a committee were nominated: MM. NEUMAYER, SCOTT, BUYS BALLOT, BUCHAN, von FREEDEN and MÜLLER. Maritime meteorology.

5. What instruments should be employed for determining the intensity of Radiation, and in what way can the comparability of the results obtained be ensured? Radiation.

M. WILD proposed to request Mr. Symons to give a report to the future Congress on the modes of observations adopted in England for Radiation.

M. JELINEK submitted that English physicists might be requested to institute experiments and to give a report on the subject. Perhaps also physicists in Germany might be interested in it. He himself would be ready to institute experiments on the subject with the various forms of apparatus which were at the Central-Anstalt.

M. BUYS BALLOT pointed out the importance of these observations on Solar Radiation and its changes according to place and time.

M. SCOTT gave a report on the results of English observers, and stated that the difficulty consisted in the fact that the results obtained with different instruments were not comparable with each other, and one hardly knew with the instruments now in use, what was actually observed.

6. What instruments are the best for determining Earth Temperatures? At what depths should the observations be taken in order to attain the uniformity which it desirable? Earth temperatures.

M. WILD remarked that the same course of action should be recommended for that question as for the preceding one, viz., to request a report (from an expert) for the next Congress.

Mr. SCOTT called on Mr. Buchan to give his experience on the subject.

Mr. BUCHAN explained the arrangement for the determination of Earth Temperature in Scotland. The Scottish Meteorological Society has observed Earth Temperature for 16 years (since the end of 1856). Thermometers were placed at depths of 3, 12, and

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Earth temperature.

22 inches in the ground, but as these observations were in the first instance of interest for Agriculture, and it was only in the second instance that they were of Meteorological importance, special attention had been paid to those at 3 inches deep. Further investigations were certainly necessary; as yet the results were small. In conclusion he drew attention to the observations of Professor Forbes, which had been published by Professor Piazzi Smyth, and contained some extremely interesting results.

M. von OETTINGEN requested that the discussion of this subject should not be closed, but that attention should be paid to a few matters which had special relation thereto. It certainly did not concern meteorological observations to determine the dependence of Earth Temperature upon the nature of the soil, and so it would be important to consider the proposal that all such observations should be made in soil of the same character.

M. EBERMAYER gave a report of the observations of Earth Temperature instituted by him on Lamont's method. He recommended that procedure very strongly, on the ground of comparisons which he had made with the earth thermometers by Greiner of Berlin, which differed about one degree from Lamont's. He drew a sketch of his arrangement of the observations, which could be seen in some detail in his book "Die physikalische Ein-" wirkung des Waldes auf Luft und Boden," to be published by Krebs at Aschaffenburg.

M. BRUHNS spoke in favour of the adoption of electrical thermometers besides Lamont's, but would have observations made at at least 12 stations, and depths of 0 to 3 metres. He hoped to be able to submit some results at the Vienna Congress.

M. NEUMAYER stated that he also had investigated Earth Temperatures at Melbourne in an elaborate manner, at the surface and at depths of 14, 31, 65, and 100 inches. The readings were taken every three hours. For the arrangement of the results he referred to his publication, "Discussion of the Meteorological and " Magnetical Observations made at the Flagstaff Observatory, " Melbourne, during the years 1858–63." Mannheim, 1867.

M. WILD, with reference to the lateness of the hour, proposed another mode of procedure, in order to bring all the questions under consideration. He thought that the more important questions, 18–25, should be first taken up.

M. von OETTINGEN supported the proposal, and it was accepted by the meeting.

The discussion of Question 18 was then taken up.

Uniform hours of observation.

18. Can uniform Times of Observation be introduced for the normal observations?

M. BRUHNS was of opinion that the fixing of the daily hours of observation should be left free to the separate countries, but it should be the duty of central stations to reduce the observations made at different hours in a uniform manner to true

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means. If, however, even the hours of observation could not be settled uniformly, a minimum of observations might be laid down, and on this head he thought that he must propose that one daily observation must be considered insufficient. Two observations, taken nearly at the hour of the daily extremes of temperature, might certainly be sufficient. For three observations a day, the equidistant hours 6^h, 2^h, and 10^h, were the most advantageous. Uniform hours of observation.

M. JELINEK opposed the exclusion of single daily observations. If the stations were very close together, daily observations at one fixed hour were sufficient, in order, in connexion with the central observatory in the neighbourhood, to be able to study local climates, and to afford means for studying the changes of the phenomena of weather. On the other hand, the only stations the observations of which should be published were those where at least three observations a day were taken. This proposal was also supported by M. von OETTINGEN.

Mr. SCOTT summarised the suggestions which had been made. He thought that an agreement on the hours of observation could never be attained, and thought that any rule which aimed at that brought serious dangers with it.

M. BUYS BALLOT was of the same opinion. He recommended Dove's division of hours $6^h.$, $2^h.$, and $10^h.$ In his "Suggestions" he had already drawn attention to another question, which was whether the observations were to be taken according to local time or astronomical time, that is the time of a definite meridian. For the barometer he thought that, in order to obtain actual simultaneity, the introduction of the second time, called by him for shortness "astronomical," was desirable.

M. von OETTINGEN declared his consent to this proposal, and was of opinion that five or six central stations should observe according to astronomical time.

M. BRUHNS asked for an explanation as to how the temperature readings should be managed, which must still be carried on at the same time as the barometer observations. He could not see why the local time should be avoided, because, from self-registering records, the data which might be desired might be extracted for any moment.

M. BUYS BALLOT explained his views by showing that for magnetic observations absolute simultaneity was required, and yet that the reduction of automatic records, which were only given at hourly intervals, could not be used in the case of many investigations, such as inquiries into disturbances, &c.

M. BRUHNS stated that he agreed to a limitation to magnetic observations.

M. JELINEK remarked that each country, according to its extent, might have one or more stations with self-registering instruments and thereby, at least for the meteorological elements, every requirement for simultaneous data would be complied with.

Mr. SCOTT communicated his experience with the seven English observatories fitted with self-registering instruments. At these there were found cases of sudden and transient changes in the

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Uniform hours of observation.

meteorological elements which disappear in the reduction of the records for the interval of an hour. As a proof of what he said he pointed out a special case from the Quarterly Weather Report which took place at Aberdeen on the 16th January 1869.

M. von OETTINGEN asked if, for instance, for equidistant hours of observation eight times a day, such as he had introduced at Dorpat, a conformity in the hours chosen were desired. His hours were 1^h, 4^h, 7^h, &c.

Mr. SCOTT asked the meeting whether conformity in this direction were requested.

M. WILD remarked that an agreement on simultaneous hours of observation brought with it the hateful question of the first meridian.

M. BRUHNS thought however that a proposal with regard to the time at which frequent equidistant observations should be instituted daily was still desirable.

M. von FREEDEN remarked that on ship-board observations were taken at the even hours. It would be well therefore to introduce this plan for land observations.

M. BUYS BALLOT stated his opinion that the choice of the hour of observation was immaterial; the important matter was that the observations should be capable of combination, so as to give a daily mean, which would only require a small correction to give a true mean. He attached importance to the necessity of dividing the observations fairly, so that we should not have too many by day and too few by night. The deduction of means from combinations in which the day observations are in decided excess (as in Italy) was, in his opinion, faulty.

M. von OETTINGEN remarked that the reason that he chose the odd hours was because they were more rarely used for observations. It seemed to him desirable that observations should be provided for these hours.

Mr. SCOTT remarked that the observations at sea were not quite so regular as was generally assumed. Thus, for instance, whalers would not confine themselves to fixed hours.

M. BRUHNS took up M. von Oettingen's proposal in order to obtain a decision on it. Should the hours of observation run from 0–23, or from 1–24?

M. von FREEDEN was in favour of 0^h as a commencement.

M. JELINEK said a distinction must be drawn according to the object for which the observations are used, *e.g.*, for the reduction of means it was immaterial whether you began with an even or odd hour. But it was not so with regard to the comparability of the individual observations. An agreement in this latter direction was desirable.

M. von OETTINGEN asked whether the day should begin with noon or midnight. MM. Bruhns and Wild, for instance, began the meteorological day at 1^h a.m. There was another question, how you were to deal with the Wind Velocities. Here you have to do with sums; how should you choose the intervals?

Mr. SCOTT remarked that in the Quarterly Weather Reports

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the meteorological day began with 0^h (noon), and the sums of the velocity of the wind were taken from $23\frac{1}{2}^h$ to $0\frac{1}{2}^h$, $0\frac{1}{2}_h$ to $1\frac{1}{2}^h$, &c., so that the centre of these intervals agreed with the period of observation. Uniform hours of observations.

M. von FREEDEN observed that at sea the day was counted from 0^h to 0^h.

M. BUYS BALLOT said that the observations made on the same day could not be separated from each other.

M. BRUHNS proposed that, as opinions were so very much divided at present, it would be better to postpone this question till the Meteorological Congress next year, and with it the question whether it would not be good to introduce generally the astronomical division of time, in order to bring the continental observations into harmony with the English. The meeting agreed thereto.

19. Can rules universally applicable be laid down for the Verification of Instruments and the Inspection of Meteorological Stations? Verifications and inspections.

M. WILD made a proposal that the Conference might adopt it as a principle that meteorological stations should be inspected at certain periods, so that at least every five years, or certainly every 10 years each station should be inspected at least once. First of all there must be an accurate verification of instruments at the central observatories.

M. BRUHNS stated that when the Saxon organization was established he had obtained means for a yearly inspection of stations, but after the first three years he had found that an inspection at such short intervals was no longer necessary. For the barometer, inspections within short periods were always desirable. It would however be impossible at this meeting to determine the period at which an inspection should be made, all that could be done was to express a wish that an inspection should be made as frequently as possible.

Mr. BUCHAN held it particularly desirable to make an inspection at least every two years. He did not attach so much importance to the testing of the instruments as to the advantages arising from personal contact with the observers. This opinion should be expressed by a competent authority. The instruments should be verified at the place of observation, and the Rain-gauges in particular should be well looked after.

Mr. SCOTT communicated his experience on his mode of inspecting the stations. Admiral FitzRoy had never visited his stations. Mr. Scott found that for stations which sent in Daily Telegraphic Weather reports, it was not necessary to take instruments on the inspection. The daily comparison of the reports which were received by telegraph, permitted you at once to detect any change which had taken place in the instruments. Kew barometers will perform perfectly well for 8 to 10 years. A spare barometer was placed at each station, in addition to the

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Verifications and inspections.

observing barometer. Every instrument was first tested at Kew and the correction determined. If, when he visited a station, he found that the difference between the two barometers had remained constant, he had sufficient security that no change had taken place in the observing instrument.

M. BRUHNS always took normal instruments with him on his inspection, and compared them with the instruments at the stations. He found that hanging up the barometer obliquely between the times of reading was not satisfactory for its preservation, because air gradually got into the Toricellian vacuum. Since this method had been given up the condition of the barometers was much more constant. For the thermometers which were given out to the stations, the limit of error was $\frac{1}{10}$° Reaumur. For the barometers he thought that a correction as much as 0·1 millim. might be admitted.

Mr. SCOTT remarked that he did not compare the barometers at the stations with a standard instrument. If the two barometers at each station agreed to within ·005 inch, after the constant correction had been applied, he was content. If the difference were greater the barometers were changed. Three thermometers, previously tested at Kew, were issued to each station. If errors exceeding 0°·3 F. were found in new thermometers they were rejected.

M. WILD asked M. BRUHNS if, when the errors exceeded the limits which had been assigned, he applied corrections or rejected the readings altogether.

M. BRUHNS answered that in the latter case he exchanged the instrument either at the inspection or soon after, and therefore he always took instruments with him on his journey for this purpose.

M. WILD remarked that he gave the greater corrections of the instruments to be applied at the stations.

M. JELINEK said that he could not lay down any fixed limits for the dependability of instruments which should be sent to the stations, because he had always to contest with difficulty in obtaining funds for providing the instruments. For barometers, in general, a correction of 0·2 millim. was considered admissible, for thermometers 0°·1 to 0°·15 C. It was desirable also to satisfy yourself occasionally that no change had taken place in the normal instruments.

M. NEUMAYER said that at the establishment of the meteorological stations in Victoria, it had been assumed as a principle to inspect all stations and compare the instruments, and the observations of the stations the instruments of which had never been compared had not been published. Moreover, the directors of the chief observatories in Australia had made arrangements for the mutual comparison of their instruments: Melbourne, for instance, with Sydney, Hobarton and South Australia. It was a much more difficult thing in those countries to carry out the inspection; but still they thought it their duty to lay down the principle, but could not bind themselves to a definite time.

M. von OETTINGEN remarked that it was a very difficult

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thing to make standard thermometers. In his paper on the calibration of thermometers he had drawn attention to the fact that there was a small error to be avoided in Bessel's method, the correction for which he had given. By means of his investigations on this subject he had attained a great facility in calibration, and he offered to calibrate a large number of thermometers if the instruments were sent to him; an offer which was accepted with thanks by the directors of meteorological institutes who were present. Verifications and inspections.

M. WILD was of opinion that even the careful calibration of standard thermometers was not sufficient to secure comparable results. Two different thermometers, accurately tested at their fixed points and carefully calibrated, could, according to Regnault's investigations, differ to the extent of 0°·2 or 0°·3 at 50° C., owing to the difference in the expansion of the glass. He proposed to test the Standard Mercurial Thermometers at all the Central Institutions with each other, and to compare one of them at least with the Air Thermometer, so as to be able to refer to the latter all statements as to temperature. At 50° C. the difference between the Mercurial and the Air Thermometer might be 0°·5, and at very low temperatures still greater differences might be expected.

M. von OETTINGEN, on the contrary, maintained that the greatest correction at 40° was not above 0°·26. He thought that it was remarkable that the boiling point of the thermometers remained constant, but not so the freezing point, as is well known.

M. BRUHNS requested MM. Wild and von Oettingen to give a report on this subject to the Vienna Congress, a request which was supported by the meeting.

Mr. SCOTT remarked that not more than two or three points on the entire thermometrical scale were known with sufficient accuracy. He further observed that delicate thermometers might be sent to stations in the following way:—the thermometers should be first put in a suitable thick indiarubber tube, and then packed in a box. By this means instruments can be sent without injury even to extra European countries.

Mr. BUCHAN then expressed his readiness to give a report on the regular inspection of the Scotch meteorological stations, and as a result of the deliberations of Question 19, a resolution was adopted by the meeting that—

"It was desirable to make a periodical inspection of the stations of each system as frequently as possible."

20. What are the rules and what the intervals of time for which the Means of the several Meteorological Elements should be calculated? Which is the better plan, to begin the meteorological year with December or with January?

M. PRESTEL spoke for December as the beginning of the year, and illustrated it by the yearly course of temperature at

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Calculation of means.

Emden, which ought to suit the whole of Europe. There are only civil and no scientific reasons for beginning the year with January. He further drew attention to the yearly course of barometrical pressure at Emden, which also agreed with a yearly period, beginning with December.

Mr. BUCHAN gave his opinion for January as the beginning of the year, and remarked that in the Shetlands and Orkneys the minimum temperature occurred in February, and even in March. If any reason could be brought for a definite epoch for beginning the year, that epoch would certainly be January. At sea the temperature agreed on the whole with the conditions in Scotland, therefore M. Prestel's remarks were not valid.

M. HANN also drew attention to the fact that if it was intended to fix the beginning of the year for universal adoption, you should not start from the course of the meteorological elements in this climate, because this course might be quite different in different parts of the globe.

Mr. SCOTT remarked that he began the year with January.

M. BUYS BALLOT was for December as the beginning of the meteorological year, because that in that case, in each yearly volume, the information for all the four seasons might be given by combining the months in threes, consecutively, while in the other case the observations of the winter must be divided between two volumes.

M. WILD remarked that it made no difference with what month you began the year, for there was no period for this which had any physical basis, it was therefore best to follow the Civil Calendar, for by this means you preserved a close relation to common life.

M. JELINEK said it was immaterial, for the means, where you placed the beginning of the year; it was only for single years that the question had any importance. Moreover, most systems of observations began the year with January.

M. PRESTEL urged the importance of Seasonal means for the purposes of agriculture. It was very necessary to pay attention to these requirements.

M. von FREEDEN remarked that the Prussian system of observations, as one of the oldest, had adopted December as the beginning of the year, chiefly in order to suit itself to the requirements of the agriculturists, for whose benefit the organization had been established.

M. von OETTINGEN was not disposed to agree with the mode in which discussion of the present question had been taken up. The first point which ought to have been begun with was the settling of the first subdivisions of the year. A decision on this question involved that about the commencement of the year. After the Daily Means, the natural units for meteorological periods, we came to the Five-day Means, the combination of the days in fives, the only equi-distant periods in the year. If it was wanted to have Normal Values for the meteorological elements, first and foremost Daily Means were not suited for this, for there was no hope for eliminating the disturbances in less than a century. The Monthly

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period, however, would be too long for this, and the Monthly period had no meteorological basis, and was a mistake, owing to its varying length. Here, then, we have the Five-day Means as a solution of the difficulty; for the Five-day means, a period only one twenty-fifth as long was sufficient, in order to determine Normal Means with the same probability as the Daily Means. The Monthly question might be entirely set aside, and the year divided into 73 Five-day periods, and the only thing to be decided was the day on which the first of these should be begun. Calculation of means.

M. Prestel contended for the Monthly Means as of practical value.

M. Bruhns read the opinions contained in the letters from MM. Dove, Mohn, Hoffmeyer, and Wolf. He himself voted for Daily, Five-day, and Monthly Means. Annual Means should be made according to Civil Reckoning. He himself always calculated two Annual Means, one for the Meteorological year, beginning with December, and the other for the Civil year.

Mr. Buchan remarked that he only wished to refer to the publication of annual results, and not the discussion of temperature observations. When only the means of observations for Five-days were published, many investigations, for which daily data were required, were rendered impossible. If, however, the daily results were published, all the data were afforded which could be required for any discussion of the observations. On this account he must declare himself in favour of Daily Means, and further, for Monthly and Annual Means according to the Civil Calendar. On the contrary he put no value on Seasonal means, as they were very delusive and easily led to quite false conclusions.

Mr. Scott gave Five-day Means, and also for the requirements of Civil life, Monthly and Yearly Means, according to the Civil Year.

M. von Oettingen spoke in favour of months composed of 5-day periods, and thought that the system recommended by M. Bruhns would be a great burden. He would combine every six 5-day intervals, beginning with December 2, to form a month, and have the one interval in excess embodied in November.

The Conference proceeded to division on three questions, whether Daily, Five-daily, and Monthly Means (for the Civil Month) should be laid down as a basis for meteorological calculations. The majority of the meeting decided for the division of the year into Days, Five-days, and Civil Months, as well as for the Civil Year.

They then proceeded further to discuss the question whether the year should be divided into 73 intervals of 5-days with M. Dove, or into 72 with M. Buys Ballot. Five-day means. Dove and Buys Ballot.

M. Buys Ballot said that he would rather not have joined in the discussion; even in his "Suggestions," in which all the questions which had been discussed hitherto had been mentioned, he had purposely omitted any allusion to the Five-day question, but he must express his preference for 72 intervals in order to obtain an agreement with the civil year. Up to the 31st May his

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Calculation of means.

division agreed entirely with M. Dove's, after that date there was a difference, but the middle epochs of his Five-day (or Six-day) periods agreed, to within a fraction of a day.

M. von OETTINGEN was against the introduction of the Civil Year, but as the majority had expressed themselves in favour of it, it would be necessary to reject M. Dove's system. In this case he agreed with M. Buys Ballot, for if you once leave the natural division, you ought at least to make the artificial division as convenient as possible.

M. PRESTEL spoke for Dove's Five-day means because they had been already adopted and had been made the basis for such great investigations.

Mr. SCOTT, the President, proceeded to divide the meeting. 11 of those present were for Buys Ballot's intervals, 13 for Dove's. Messrs. Buchan and Buys Ballot declined to vote.

The question was briefly raised in what way the Annual Means should be obtained.

M. BRUHNS obtains annual means by dividing the sum of the Daily Means by 365, Mr. SCOTT by dividing the Monthly Means by 12.

Sub-Committees for remaining questions.

M. BRUHNS proposed that in order to bring into discussion at the next sitting, which was the last, the questions which had not yet been touched, two committees should be chosen, one for Questions 21–26, the other for Questions 7–17. The members of these committees should consider the various questions at a private meeting and submit definite proposals on them to the next meeting of the Conference.

This proposal was accepted, and MM. BRUHNS, JELINEK, and WILD were chosen as members of the first Committee. For the second MM. EBERMAYER, HANN, PRESTEL and SCHODER.

The next and last meeting was fixed for the next day at noon. M. WILD was proposed as President, and the meeting was closed at 4 o'clock.

3. Protocol of the Sitting of the 16th of August.

M. WILD, as President, opened the meeting. He distributed a number of copies of M. Buys Ballot's paper, "Suggestions on a Uniform System, &c." and then called on the reporters of the two committees to present their reports to the meeting for consideration.

M. JELINEK as reporter of the first committee named at the last meeting presented his report on Questions 21–26.

Calculation of normal values.

21. In what manner and for what intervals are the Normal Values for the individual Meteorological Elements to be deduced?

One portion of this question has already received its answer in the result of the discussions on Question 20. It generally has to do with the calculation of shorter series of observations, and the committee therefore proposed a reduction to a normal

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period, which might be a multiple of five years. A new period of this nature should begin with the 1st January 1871. Calculation of normal values.

M. von OETTINGEN proposed to adopt the name *lustral* mean for the 5-yearly mean.

Messrs. BRUHNS and SCOTT expressed their agreement to these proposals, which were accepted by the meeting.

22. Is it desirable and possible to publish the Meteorological Observations of a limited number of Stations in each Country in a uniform manner, and within a reasonably short time after the Observations have been made? Uniformity of publication.

On this head the committee recommended the publication of original observations of a certain number of stations of each country, and proposed a scheme for the form of this publication which agreed very closely with the Russian system. Three observations a day should be given, of Pressure, Temperature, Relative Humidity, Wind Direction and Force, and Rainfall, and on a uniform system, so that the corresponding data of different stations and different countries could be immediately compared with each other. For the means, and whatever else should be added to such a publication, according to its character, (as, for instance, History of Weather and Special Phenomena), &c. there should be given a special place in the publication.

M. von OETTINGEN asked whether, when arranging this plan, regard had been had for the 5-day periods, so that separating spaces should be inserted between every five and five days; and whether, according to the proposal of the sub-committee, the Daily Means should be omitted.

M. WILD answered that on the first point there was no difficulty in the way of the arrangement proposed, and as regards the Daily Means they had only been left out of the proposal for want of room; but place might be found for them among the Means in the way which had been indicated.

Mr. SCOTT asked who was to print these publications, who was to pay the cost of them, and how many stations were to be included. A few stations would not be sufficient, and it would not be possible to put in all.

M. BRUHNS explained the views of the committee. Each country was to bear the cost of its own publications, and also was entrusted with the choice of its stations according to its means. No one thought of a publication like an enlarged "Bulletin International." The proposed plan represented the minimum of requirements which it seemed necessary to propose with reference to the publication of original observations.

M. SOHNKE spoke against the mode of publication which had been proposed, for he thought the observers whose results were not published would be impatient, and would give up their observations.

M. JELINEK explained the views of the committee, that it was only as regards the original observations that the restriction to a

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Uniformity of publication.

limited number of stations should be introduced, but that the results—the means—should be inserted from *all* stations of the system.

M. RAGONA asked where there was room for the daily Maxima and Minima in the plan proposed?

M. BRUHNS answered that the plan was only a proposal and could be altered on certain heads.

Mr. SCOTT recommended that you should not pledge yourself to too much. He knew what the cost of publication of the automatic records of the seven stations of the Meteorological Committee cost. He thought that it would be unnecessary to give in addition to them the readings, for the curves were sufficient to give all the data required for every epoch.

M. von OETTINGEN denied this; he wished to put the greatest weight on the demand for obtaining the original observations, for no matter how good Mr. Scott's curves were for all investigations for which only single readings were wanted, the labour was incalculable and impracticable if certain mean values had to be deduced, when you had first to reduce all the numerous data. He recommended that proposals should be laid before the next Congress of various schemes in print, so that the members might be better able to decide on the merits of the respective plans.

M. JELINEK declared that it was the object of the committee to leave the decision of the question to the Congress. There were certain other questions which had not been touched. For instance, whether you should give the 5-day Means of the different stations of a country, together, or under each station. He replied with reference to Mr. Scott's objections, that if the proposal were taken up by the Congress in the way in which the committee proposed, it would be England which would have least to change. The object was twofold; firstly, to urge the countries, from which as yet no original observations have been obtainable, to publish such, and to introduce a certain conformity into the publications which already existed, in order to render comparisons and investigations of all sorts more easy.

M. BUYS BALLOT approved the plan and remarked only that Vapour Tension was omitted from it, information of which was desired by many investigators. Relative Humidity was less important than Vapour Tension, he preferred Absolute Humidity. He could not agree with the proposal of Yearly publications, the observations should be published Monthly, as was already done by Switzerland, Italy, Holland, Norway, &c.

M. WILD saw no great advantage in Monthly publications; he was decidedly in favour of Annual. Russia was not in a position to publish Monthly. There was, moreover, special importance attached to the question of these publications being as correct as possible. This was not attainable if you had to proceed to the publication of the observations immediately at the end of each month. There would always be then a long list of subsequent corrections. The Daily Weather Telegrams fully met the requirements of the study of recent weather phenomena. These

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should certainly be published as quickly as possible. It was therefore desirable to recommend two kinds of publication, Yearly volumes and Meteorological Bulletins, the latter to be published at as short intervals as possible. Uniformity of publication.

M. Buys Ballot, notwithstanding M. Wild's representations, was in favour of Monthly publications, and this form might be accepted even for Russia if only a limited number of stations were adopted. The urgent requirement was to obtain a general view of the weather all over the globe at a time when the memory of the weather which had been experienced was still fresh.

Mr. Scott spoke against Monthly publications. Even in England they could not be carried out without difficulties, because the results of each month were not received at the Central Office until after the middle of the subsequent month.

M. Bruhns remarked finally that Vapour Tension had been only omitted from the scheme for want of room.

M. Ragona again urged the importance of the adoption of the daily Maxima and Minima in the publications.

The proposal of the committee to prepare plans for the next Congress was adopted.

23. How is the exchange of the Meteorological Publications of different Institutions and different Countries to be carried out most speedily, safely, and simply? Exchange of publications.

M. Jelinek reported for the committee, that parcels which were not too large might be most quickly and easily sent by book post. The distribution of reports to the individual observers of the meteorological systems could finally be carried out from the Central Offices. It was not advantageous to send through the Embassies on account of the delay and inconvenience; but in certain cases the Governments should be requested to instruct their Consulates to facilitate the intercourse with Foreign Institutes and Observatories, and to undertake the transmission of the publications. Another question was how acknowledgments for parcels received should be sent most cheaply and safely.

Several proposals were made in reference to this, especially the announcement of the forwarding of parcels by post-cards, with a coupon, which might be transmitted with the stamp of the receiving Institution as soon as the parcels had arrived safely.

M. Bruhns recommended that wherever there was a society as at Washington, Haarlem, &c. which offered to distribute publications in their own country use should be made of it; and that the Central Offices should designate certain institutes or firms who would undertake the transmission of publications for exchange.

24. Is it desirable that in each country there should be established one or more Central Institutions for the direction, collection, and publication of the Meteorological Observations?

M. Jelinek gave the report of the committee. The committee was of opinion that a Central Meteorological Institute

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Establishment of central offices.

should be established in every large country for the objects named. For the purpose of uniform management it was desirable that there should be only *one* such central institute, and not several, in each country. Wherever, as *e.g.*, in Russia, the great extent of country makes it appear desirable, there might be Normal Observatories for certain regions which should undertake the superintendence and direction of stations situated near them. But these Normal Observatories should be always subordinate to the Central Meteorological Institute and should work according to the plan laid down by it. With regard to Marine Meteorological Observations, the committee expressed its opinion that there should be either an entirely separate office for Marine Observations, or that in the Meteorological Central Office there should be a separate Department instituted, with a separate head.

Mr. BUCHAN explained that the Scottish Meteorological Society was not in a position to agree to a proposal according to which there should be only *one* Central Office in Great Britain for the Management, Collection, and Publication of Meteorological Observations. The operations of that Society were conducted entirely independently of Government support. In fact most of the observers were not paid* for their observations. If a central office were established the result would be that the work, which was now done gratis, must be paid for. The hundreds of people who must then be employed would not work for nothing. He therefore thought that the question could not now be decided.

Mr. SCOTT said that several organizations already existed in England, thus Greenwich was under the Admiralty, while the seven normal observatories lately established were managed by the Meteorological Committee of the Royal Society.

The Conference adopted the resolution by 14 votes against 6, that—

"It is desirable that in each country One, or in case of "necessity Several, Central Offices should be established, and that "those for Sea and Land Observations should be separate."

Weather telegraphy.

25. Does the interchange of Weather Telegrams appear so useful that it should receive a fuller development and a firmer organization?

M. JELINEK reported for the committee that it was desirable that the present system of Weather Telegrams, which has already been established should receive further development.

Upon this the remarks on Weather Telegraphy contained in the report of the marine sub-committee were read (see p. 44.)

Mr. SCOTT recommended that the wish should be expressed that in every large country a central office should be established for Weather Telegraphy, as was already the case in most countries. A second question, in respect to the extension of the system of the

* Correction in English edition. For "most of the observers were not paid," read "none of the observers were paid."—A. BUCHAN.

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stations which transmit Weather Reports to the Central Office of each country, and to the combination of foreign stations therewith, was explained by Mr. Scott, with reference to England, in the following sense: the principle adopted there was to pay attention only to the weather of the country itself, and for this purpose information from certain stations in neighbouring countries was indispensable; but it was not possible to meet other requirements of practical life, and *e.g.*, for Shipowners, to give Weather Telegrams from distant ports, which have nothing whatever to do with storm signals for the country to which they are sent. Weather telegraphy.

M. WILD said the main object of the committee's report was to influence Governments and the Telegraphic Directions.

M. PRESTEL recommended the extension of Telegraphic Weather Reports to the whole of Europe, and on the following plan:— a certain number of stations should be chosen, which should be just sufficient to give a general view of the changes and the conditions of the weather, and the telegrams of each of these stations should be sent to each of the others.

M. BRUHNS said that the realization of this proposal would only be possible by the help of all the Governments.

M. von OETTINGEN said he received Daily Weather Telegrams, and could only lament that Germany took no part in the system, and that the form of the Weather Telegrams from Germany was defective. The communication of the absolute readings of meteorological instruments was certainly very desirable, but it was more urgent to give the Deviations from the Normal Values. It was only these deviations which gave intercomparable figures, and offered an immediate view of the conditions of the weather. It was not very useful to add the changes, in fact they might lead to very false results. Therefore he was decidedly disposed to support the communication of the Deviations from the normal values.

M. von FREEDEN thought that it would be often impossible to obtain the necessary Normal Values. He was also of opinion that the German Weather Telegrams had been formerly not quite satisfactory, but an improvement had been made in this respect. He recommended an arrangement of the stations in a N.E. and S.W. direction, as the best for the whole of Europe.

M. BRUHNS proposed to refer the report of Weather Telegraphy for the Congress of 1873 to a sub-committee.

M. WILD thought that this matter might be handed over to the Marine sub-committee.

Mr. SCOTT was of the opinion that M. Prestel's proposal to send all telegrams to all stations was impracticable, and would break down on the point of the wordiness of the body of telegrams, which must cause confusion.

M. WILD said that for each country there was a definite area, within which those stations lie whose Weather Telegrams would be of immediate interest to the same, and this might influence the choice of the stations.

Upon this, Question 25 was handed over to the Marine sub-committee to furnish a report for the Congress.

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Plans for Congress.

26. What Regulations should be adopted in order to carry into effect the Decisions and the Objects of the Meteorological Congress?

It was recommended to draw up a full Protocol of the Proceedings of this Preliminary Conference, and to establish a Permanent Bureau to prepare for the actual Congress next year.

M. BRUHNS stated the reasons which were in favour of Vienna as the place for the Congress of 1873. They are the Exhibition, which would ensure the attendance of a large number of visitors, and the newly erected Meteorological Institute, whose complete equipment with new instruments might be expected by that time.

The proposal, then, to summon the Congress for next year for Vienna was unanimously adopted.

Similarly, on the motion of M. BUYS BALLOT, MM. WILD, JELINEK, and BRUHNS were chosen unanimously for the Permanent Bureau.

M. BRUHNS proposed to leave the duty of fixing the time for the invitation to the Meteorological Congress in 1873 to this Committee, and only in general terms to fix it for the end of September or the beginning of October.

The meeting agreed thereto.

M. von OETTINGEN proposed to establish an Organ for all preliminary arrangements which were to be made previous to the meeting of the Congress.

M. WILD was of opinion that the materials referred to would not be sufficient either in quantity, or in regularity of appearance, to require a special organ, but proposed to employ the Journal of the Austrian Meteorological Society as the organ.

M. JELINEK agreed, and promised to introduce all proceedings or communications, &c., which had reference to the Congress, into the Meteorological Journal or as an Appendix thereto.

The PRESIDENT, M. WILD, requested the second sub-committee, which had been appointed to discuss Questions 7 to 17, to submit their proposals to the meeting.

M. HANN as reporter for the committee, which consisted of MM. EBERMAYER, PRESTEL, SCHODER and himself, stated that they had arrived at the following conclusions.

Hygrometry.

7. What apparatus should be employed for the determination of the Hygrometric condition of the air? Are the Wet and Dry Bulb Thermometers sufficient? Can the Hair Hygrometer be employed, and under what restrictions?

The committee recommend that, inasmuch as the Psychrometer is untrustworthy at low temperatures, and also in cases of extreme dryness, and the Hair Hygrometer fails also at the dew point, and as up to this time there is no Hygrometer in existence,

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at least for regular observations at stations, which gives precise results as to Moisture, in all cases; a wish should be expressed that there should be further experiments on the subject, and that the general experience on this question should be collected.

M. NEUMAYER recommended the adoption of Regnault's Hygrometer with an aspirator. In Australia he had observed, every three hours, a Daniell's hygrometer with an aspirator, by the side of the Psychrometer, and had obtained thoroughly satisfactory results. You could hardly employ a more accurate instrument than that which he named for the systematic determination of the moisture of the air. It seemed to have been altogether forgotten, one of the reasons of which was certainly that Daniell's instrument in its original construction was not easily managed, but he himself, in very high temperatures, and extreme dryness, with 8% to 10% of saturation, had found no difficulty. However, in great heat, which comes in Australia as a result of the Northerly winds in summer, the air for the aspirator must be drawn from cool places.

M. von OETTINGEN remarked that with Regnault's Hygrometer he had not been able to obtain any deposit with very low temperatures, and that probably it would prove not practicable.

Mr. SCOTT described briefly the new Sulphuric Acid Hygrometer by Whitehouse, which perhaps might be generally employed.

M. WILD had for several years introduced Hair Hygrometers, in addition to Psychrometers, as an experiment, owing to the fact that at the majority of the Russian stations the Psychrometer is of no use in winter owing to the lowness of the temperature. According to the experience which had been already gained, they performed admirably, with few exceptions. If properly managed they could entirely replace the Psychrometer at 0° C. and at low temperatures, if they were occasionally verified by comparison with it above 0° C. He had moreover often found the two instruments in perfect accordance between — 5° and — 15°.

M. NEUMAYER remarked that Erman in his great travels round the world thought that he had gained the experience that the hair-hygrometer gave very good results, so that it would be well worth the trouble to take into consideration the use of the hair-hygrometer under certain conditions.

M. BRUHNS said that the vapour tension of the air, at temperatures below zero, was sufficiently important to justify the proposal that experiments should be made with the Hair-hygrometer and the Psychrometer.

MM. WILD, BRUHNS, and JELINEK expressed themselves ready to institute comparative observations and experiments on this subject.

M. WILD remarked that comparisons when the air was excessively dry were also very desirable, and he requested M. von Sternbach to make special observations on the occurrence of the Föhn-wind in winter at Bludenz.

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Hygrometry.

M. von STERNBACH expressed his readiness to do so.

M. BUYS BALLOT undertook to make experiments with Baumhauer's Hygrometer.

Mr. SCOTT drew attention to the difficulties which were met in the employment of Self-registering Hygrometers, and recommended some comparisons with the Sulphuric-acid Hygrometer.

M. NEUMAYER drew the attention of the Conference to the importance of the investigation of the relations between Radiation and Moisture. A former difference of opinion on this important subject had now in great measure disappeared. An element which had such an influence on climatology could not be entirely disregarded, therefore he recommended to the sub-committee to consider Questions 5 to 7 specially.

Mr. BUCHAN agreed with the preceding speaker, that the question of the action of Radiation and of Latent Heat should be thoroughly investigated, and it was especially the duty of the great observatories to undertake the complete treatment of this question. Much which was as yet unintelligible in the climates of Australia and India would be explained by such enquiries. Whoever really works up the Hygrometrical question in its relation to Radiation will, if a few results only be obtained, make a great step in the advancement of science. He said that he had spoken strongly on this subject, but certainly not too much so.

M. PRESTEL expressed his opinion that simple relations might be established between the extent of Evaporation and the condition of Relative Humidity, and the subject should be specially investigated.

Direction of wind.

8a. In what way can uniformity in describing the Directions of the wind be attained?

The sub-committee recommended, in order to remove the difference between the nomenclature of the East and West winds in the Latin and Teutonic languages, and to avoid the misunderstanding which arises from the use of the letter "O," to introduce in general the letter "E" for abbreviation for East wind, "W" for West wind, *i.e.*, the designations used in England; a proposal which was received by the Conference after some remarks.

M. BUYS BALLOT recommended the use of arrows, in place of letters, for indicating the Direction of the Wind.

M. von OETTINGEN said that even if arrows were introduced, you could not avoid using letters in many cases; as, for instance, in the Telegraphic Weather Reports published in the newspapers. Otherwise he was for the introduction of the arrows, where it was only the facility of inspection which had to be considered. But for calculation you must introduce another mode of describing the wind. In this case the 8 or 16 directions were insufficient; you must come to the Components, as he had proved and maintained in the last volumes of the Dorpat Meteorological Observations.

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8b. Is the deduction of the mean Direction of the Wind by Lambert's formula desirable? Is it desirable or not to include very light winds (force 0) in constructing Wind Roses for the Direction of the Wind? Lambert's formula.

The sub-committee stated their opinion that the use of Lambert's Formula was not advisable. The Calms should be introduced separately, and designated by a separate abbreviation, such as the letter "C."

M. von OETTINGEN spoke in favour of his mode of discussion of the wind. He explained briefly the construction of his new anemometer, which reduces the wind immediately, according to direction and force, to the four axes of a system of rectangular co-ordinates, and so meets all the requirements which could be made from a mechanical point of view, for the representation of the movements of the air. The description of the apparatus would be given at greater length in the next Dorpat Report. He hoped to be able to submit the apparatus itself to the Meteorological Congress at Vienna, and to give the results obtained by it at full length in a paper.

M. HANN spoke in favour of the recommendations of the sub-committee and against Lambert's Formula. As regards the latter in a form of reduction to a single resultant, which had originally been adopted, usually without attention to the Force, enough had been written already, and its worthlessness had been sufficiently proved. M. von Oettingen also declined to follow the last step in using it, and had not gone further than the four Components. But these were not at all sufficient for all investigations, especially of a Climatological nature. If you took the four Components, it was not very easy to see why you should not take eight Components, that is the usual eight principal points without any reduction.

There were two points to be decided and fixed. If the question was the communication of results from the observations, a reduction to four Components might be justifiable. But this was certainly not the case when you had to deal with the publication of original observations. In these you could not insert values which had been already reduced, and were only useful for one definite series of investigations, but must give the observations themselves, in order that they might be employed for investigations of any kind.

M. von Oettingen's proposal was perfectly right and satisfactory as long as the question of the Quantities of Air in motion was dealt with, but this was not the only question. In Climatological investigations, for instance, it was especially the Frequency of the different winds which had to be considered, without reference to their force, and the four components were insufficient for representing the wind conditions which were characteristic for the various climatological areas, and they in many cases actually led to wrong conclusions. In the original observations it was necessary therefore to give at least eight directions, and if you gave the

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force as well, the reduction to four components, for the object which had first been named, could easily be carried out at any time.

The proposals of the sub-committee were adopted by 12 votes to 7.

Scale of wind force.

9. What scale should be employed for the Force of the Wind when it is not determined by actual measurement, but only by estimation?

Recommendation of sub-committee. The scale of 4 for Wind Force is insufficient, according to the experience which has been gained; that of 10, on the contrary, gives too minute distinctions, which allow too great latitude for choice when the wind force *is simply estimated*, and therefore the scale of 6 is to be recommended. It is already introduced in large systems of observations, and presents at the same time the advantage of easy reduction to the Beaufort's scale, which will soon come to be adopted generally at sea.

M. JELINEK spoke in favour of the scale of 10, which is now most generally employed, and seems best adapted to the metric scale and to other meteorological measurements.

M. von STERNBACH also defended the scale of 10, which he thought must be called even insufficient for the more accurate determination of the force of wind.

M. von OETTINGEN said the first point was to give a precise definition of the scale of 6; without that he thought the proposal insufficient. For every figure of the scale the corresponding velocity must be assigned.

Mr. SCOTT said that the scale of 6 did not give minute enough distinctions. He explained the principle on which Beaufort's scale of wind force was based, and said it was very difficult to give the velocities which corresponded to each figure of the scale.

M. BRUHNS spoke in favour of the scale of 10, and suggested that the determination of the question should be postponed until the next Congress.

M. WILD briefly described the experiments which had been made with simple apparatus for the determination of the Force of the wind, with respect to which he referred to the St. Petersburg bulletin.

M. BRUHNS proposed that observations should be made at several observatories on the relation which the estimated Force bore to the measured Velocity, in order to give a basis for determining the scale.

M. JELINEK thought that such an investigation should be carried out as well at the observatories on the continent, where the scales of 10 or 6 are used, as at sea, or on the coast where the Beaufort scale of 12 is employed.

M. WILD remarked that the Velocity of the wind depended on the altitude at which the anemometer was erected; and its height above sea level must also be taken into consideration.

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M. von FREEDEN drew attention to the circumstance that, when the anemometer has been erected on the flat roof of a tower, it has happened, in consequence of the ascensional movement of the air at the building when the storm blew straight against it, that the anemometer gave a velocity far too low, inasmuch as there was a calm on the actual roof. Scale of wind force.

Mr. SCOTT agreed with this remark from his own experience.

The Conference referred the question of the comparisons, and the determination of a scale of Wind Force, to Messrs. BUYS BALLOT, JELINEK, and SCOTT.

10. Is it desirable to introduce simple counting instruments for determining the Velocity of the Wind? What units should be taken for the discussion of the Velocity of the Wind? Velocity of wind.

The proposal of the sub-committee went so far as to recommend the adoption of Robinson's Anemometer in its simplest form for the determination of the Velocity of the wind prevailing at the time of observation. In agreement with the unit which is taken in all physical works, the velocities should be given in Metres per Second.

Mr. SCOTT remarked with reference to Robinson's anemometer that he hoped that soon experiments would be instituted in England in order to determine whether the simple relation between velocity and the number of revolutions of the cups was quite correct or not.

The recommendation of the sub-committee was adopted.

11. What is the best form, size, and mode of exposure of Rain gauges? At what hour of the day should the fall be measured? Rain gauges.

The recommendation of the committee went so far as to suggest that a complete report of the experience which had been as yet gained, with reference to the first portion of the question, should be prepared by a committee for the Congress of 1873. As for the hour of observation, an hour in the morning should be recommended, if the conditions permitted it, and, in addition, an hour in the evening.

Mr. BUCHAN remarked that the first portion of the question had been almost exhaustively settled by experiments and observations, accounts of which would be found in Symon's "British Rainfall" and the "Meteorological Magazine."

M. GALLE drew attention to the great influence of height on the erection of rain gauges, and drew attention to the great mass of observations which had been accumulated in Scotland from 1854 to the present time.

Mr. BRUHNS proposed that it should be recommended that all rain gauges should be of the same form, the same area, and erected at the same height; that the best receivers were circular, $\frac{1}{10}$th of a square metre in area, at a height of $2\frac{1}{2}$ metres abve the ground;

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Rain gauges.

but it was still desirable that at the central stations, in addition to their present rain gauges, others should be erected, by which the dependence of the quantity of rain collected on the size and form of the rain gauge should be determined.

M. BUYS BALLOT supported the proposal and the meeting adopted it.

M. BUYS BALLOT remarked, with reference to the second point of Question 11, that he should like to reverse the recommendation of the committee, viz., that the original recommendation should be to measure the rain in the evening, and if possible in the morning also. By this means you avoid the error which arises if the rain which is measured in the morning is put down in the register for the day on which it is measured.

M. von OETTINGEN remarked that the answer to this question depended on the decision which was to be made as to the commencement of the meteorological day.

M. WILD, for the same reason, recommended that this question should be left quite open for the next congress and M. JELINEK agreed with him.

The meeting adopted the proposal of leaving the question open.

Rain and snow.

12. Should the days of Rain and Snow be counted separately or together?

The recommendation of the committee was that there should be three columns in the observing form, headed Rain, Snow, and Mixed Days (days with rain and snow.)

M. von STERNBACH remarked that by this the duty of the observers would be much increased, for they must constantly be watching whether a shower of rain had not turned to snow, and the contrary.

M. WILD answered that each observer would only have to enter his observations as before, and that a completely accurate registration was impossible, inasmuch as observers could only put down in a general way what fell during the night.

The recommendation of the Committee was adopted.

Hail.

13. Is it desirable in giving the falls of Hail to draw a distinction between "Graupel" and true Hail?

The Committee recommended to carry out this separation, as far as possible, in the interests of agriculture and practical life.

M. BRUHNS declared that he agreed with the proposal.

M. SOHNKE opposed the proposal, for it was impossible to draw a strict line between "graupel" and hail; therefore the distinction could not be maintained, and was unscientific.

M. WILD remarked that according to the Russian instructions hail and "graupel" were separated. Hail was only given with thunderstorms.

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M. PRESTEL said separation was very possible. Hail had always an envelope of clear ice; the grain of "graupel" could be clearly recognized as a spherical snow-flake. He drew finer distinctions, for "gries," "graupel," and hail. Hail.

14. In counting Thunderstorms, should the Storms as such or the Days of Storm be given? In what way should the instances of Sheet-lightning be noticed? Thunder-storms.

Recommendation of the Committee: Only Days of Storm should be counted, and not the separate storms. Sheet-lightning should also be given, if it be independent, and not a consequence of storm at the place of observation.

15. What apparatus is to be recommended for the measurement of Evaporation? What is the most suitable exposure for the Vaporimeter? Evaporation.

The sub-committee recommended the Conference to refer this question to a committee for a report for the Congress of 1873, as it still required an accurate investigation.

M. PRESTEL recommended his vaporimeter, and referred to the description in the Austrian Journal for Meteorology, Vol. I., p. 193.

M. EBERMAYER had made very good observations with Lamont's vaporimeter, and he therefore thought that he could recommend it; and his apparatus also for the determination of the evaporation from the soil, when kept moist, acted quite satisfactorily. With reference to this circumstance he referred to his work, "Die "physikalische Einwirkung des Waldes auf Luft und Boden."

M. NEUMAYER said that he had also made observations with various vaporimeters in Australia, but he thought that it would not be in the interest of the Conference to enter into these details of the description of instruments. On this subject, as well as on several others on which he had not expressed his opinion, for similar reasons, he would place himself in communication with the committee, and give them his experience; a proceeding which would be very much to be recommended, in the interest of the subject, to the other gentlemen.

16. In what way should the proportion of Cloud in the sky be estimated and indicated? Is it desirable to introduce for Clouds, Hydrometeors, and for other extraordinary phenomena, a nomenclature which shall be independent of local language, and therefore universally intelligible? Proportion of cloud.

The Committee recommended to give the degree of cloudiness of the sky by figures from 0 to 10. "0" should be "blue sky," and "10" "entirely overcast." The introduction of generally intelligible symbols for the different classes of hydrometeors

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(except the proportion of Cloud, for which figures are proposed), as for Rain, Snow, Hail, "Graupel," Thunderstorms, &c., was desirable. A table of the symbols which are used at the present time in various systems of observations, should be submitted to the Congress, to make a choice from them.

Extra observations.

17. Should other Meteorological Elements than those already enumerated, *e.g.*, Atmospheric Electricity, &c., be included in the scope of normal observations, and what are the best instruments for observing them?

The recommendation of the sub-committee was to the effect that this question, which could only have reference to large observatories, should also be entrusted to a committee for the preparation of a report for the Congress.

M. PRESTEL reminded the Conference of the importance of Ozone observations, and the desirability of uniformity in the Ozone papers and scales employed for observations.

M. EBERMAYER recommended observations on the level of the water in the soil, and on the introduction of rain-water into the soil, by means of the Lysometer.

In consequence of the lateness of the hour, which forbad a thorough discussion of Questions 13–17, the Conference, on M. BRUHNS' proposal, requested MM. EBERMAYER, SCHODER and SOHNKE to give a report on the questions mentioned to the Congress of 1873.

Finally, at the request of the President, the report of the sub-committee on Marine Meteorology was submitted by M. NEUMAYER.

REPORT OF THE SUB-COMMITTEE ON MARINE METEOROLOGY TO THE METEOROLOGICAL CONFERENCE AT LEIPZIG.

Meeting of the 16th August, at 7h. 30m. a.m.

Present: MM. BUYS BALLOT (Chairman), BUCHAN, von FREEDEN, MÜLLER (Secretary), NEUMAYER, and SCOTT.

After reading the Resolution which had been adopted by the Conference at its meeting on the previous day, with respect to the nomination of the sub-committee, the five points proposed by M. NEUMAYER were read as a basis for discussion. The questions were handled at considerable length, and the discussion was extended to minute details.

Uniformity in methods and instruments.

1st. Thorough uniformity in methods and instruments should be aimed at, in the same measure as for observations on shore. This will be most satisfactorily attained by the chiefs of the central institutes—the establishment of which in all countries, in which they do not already exist, and in which the maritime in-

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terests demand them, must be declared as absolutely necessary—entering into relations with each other and agreeing on the separate details, the construction of the instruments, the hours of observation, the journal, &c.

This proposal was unanimously adopted after a short discussion.

Unity of scales.

2nd. Unity of measures and scales is desirable, and to this end the introduction of millimètres for the barometer and the centigrade scale for the thermometer should be aimed at. While, however, the comparison of standard instruments of the individual central stations must be insisted on, the uniformity of scales is at present only declared as desirable.

A long discussion ensued on this question, the result of which was that none of the gentlemen present undervalued the importance of a uniform measure, Metre and Celsius. But, for use at sea, they found that the maintenance of the English barometer scale by certain nations might still be justified, in consequence of the difficulty of obtaining uniformity on the point; they must however express themselves against the use of *two* distinct measures.

M. Buys Ballot expressed this opinion in this sense: that he was so convinced of the necessity of a uniform scale that he himself would give up millimètres, for the English measures, on the condition that uniformity could be obtained thereby.

Co-operation of navies.

3rd. The committee would urge the importance of the co-operation of the Navies, inasmuch as by their assistance, and by the opportunities afforded thereby of completeness in certain observations, the determination of factors and constants is rendered possible, which can be used with advantage for the reduction of certain results derived from the general system of observations.

The sub-committee unanimously adopted this resolution also after a long discussion.

Division of work.

4th. With reference to the utilization of the results, the committee would urge similarly the importance of uniformity in the methods employed. In close relation therewith was the carrying out of the division of labour of the central stations of the individual states. This principle must be recognised as of the greatest importtance for the further development of Marine Meteorology. The repetition of work over definite regions, with reference to the area to be investigated, must be declared as indefensible in the interests of this development.

Mr. Scott remarked that the Meteorological Office in London had determined hitherto only to permit the copying of any scientific documents on the condition that the applicant paid the cost.

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On the contrary M. BUYS BALLOT remarked that he, as formerly, would be prepared in future to adopt the consequences of the proposal which was submitted; and all who were present finally agreed thereto.

M. von FREEDEN observed that up to the present time the matter had been arranged by mutual agreement, and that a pressure could hardly be exerted.

Weather telegraphy.

5th. The sub-committee would recommend that the Conference should, to be in unison with most authorities of science, express itself to the effect that the question of the practicability and utility of Weather and Storm Signals in Europe must still be considered as an open one from many points of view. They would recognise the importance of more thoroughly sifting the material which is in existence, and for this purpose named a sub-committee which should consist of MM. BUYS BALLOT, SCOTT, and NEUMAYER, with power to increase their number. All authorities in this branch of science, among whom M. Mohn was especially named, should be requested to give their opinion, and the results of this investigation should be drawn up in a report which should be published at least two months before the meeting of the Congress in Vienna.

After some discussion with respect to the great difficulties which were connected with carrying out this proposal, the sub-committee passed unanimously the resolution to adopt this point also.

The sub-committee recommended the Meteorological Conference to adopt all these their conclusions, and in this case prayed it to embody the present Report in the general Protocols of the Conference.

Finally, after several questions and debates, the Conference adopted all the proposals of the sub-committee.

M. JELINEK, in the name of the issuers of the invitation, expressed to the Conference their heartiest thanks for the active co-operation they had met with at its hands, and at 4 o'clock the Conference of Meteorologists in Leipzig was declared closed.

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APPENDIX.

APPENDIX A.

COMMUNICATIONS ADDRESSED TO THE METEOROLOGICAL CONFERENCE IN LEIPZIG.

I.

Geh. Regierungsrath H. W. Dove to Director C. Bruhns, Leipzig.

Berlin, July 24th, 1872.

I BEG you to excuse my attendance in Leipzig as I must get some mountain air in August. As for the questions to be laid before the Conference with the hope of arriving at some general agreement, I should wish that unanimity were attained on the following heads:—

1. *Division of Time.*—For Non-Periodic Variations the hours 6, 2, 10, seem to me the best arrangement, with Five-day means for the yearly period, beginning with January 1st. For the years and months I think it best to hold to the old division, as a unanimous agreement of all observers to a change is hardly probable; of course Old Style is inadmissible, we must use New Style. Uniform hours for the daily means for all countries are scarcely to be hoped for, as the hours convenient in one country are not so elsewhere. At all events it seems to me necessary to state what correction has been applied to reduce the mean of the hours of observation to a true mean. It seems to me very desirable to give, in addition to the means for the individual stations, the reduction to a normal station, as I have always done in the case of my stations. If no such normal station exists, observations at similar hours are the only ones we can employ in isothermal inquiries. Inasmuch as the hours which suit one instrument are not necessarily suitable for other instruments, it appears to me advisable to consider the Thermometer as the instrument which rules the choice of hours, owing to the magnitude of the diurnal variation of temperature.

By time I mean local time; this certainly interferes with the investigation of really simultaneous phenomena. To refer everything to the time of one place, as was done by Gauss in his inquiries on Terrestrial Magnetism, seems to me impracticable for Meteorological investigations, and rather disadvantageous than otherwise.

2. I have already proposed, and still think it desirable, to adopt the English denominations for the direction of the wind, E. for east and W. for west, for then there is no possibility of error for Germans and Frenchmen. The plan employed in the Swiss system seems to me thoroughly unpractical, where we have, in the same book, different terms for the stations where French or German are spoken respectively. The employment of 8 or 16 points for the wind may be left to the observer if the vane is not graduated so as to give degrees. If there be degrees, however, it must be settled what degrees correspond to the several points, *e.g.* N.N.E. from to . The degrees should be counted as on a clock face, and also counted in the same way in the Northern and Southern Hemispheres, even though the direction of gyration of the wind is different.

I think Robinson's principle the best for anemometrical inquiries. The vane must possess an absolutely free exposure. The determination of the distribution of Pressure, Temperature, and Vapour in the windrose is desirable, together with the law of variations of the instruments, which has only been ascertained for a few stations, by comparing the observation before the shift of the wind to a certain point with that after the shift.

3. *The Scale.*—The introduction of the Centigrade scale into meteorological inquiries does not appear advisable to me until the English and Americans give up their Fahrenheit's scale. The division to tenths is universally referred

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to the unit, whatever the degree is. In all the older investigations Fahrenheit and Reaumur's scales are so decidedly predominant that I have always preferred Reaumur's scale for my inquiries. The attempt of Forbes at Chiswick to introduce the Centigrade scale instead of Fahrenheit's failed completely. Fahrenheit's scale offers the advantage of giving only positive quantities almost all over the Temperate Zone. Negative degrees could certainly be avoided, if a new scale were introduced, with 100 added to it. This addition could be made to the older observations. The sole inconvenience in the Fahrenheit scale is found in inquiries on the distribution of plants, as we then only use readings above the freezing point.

The introduction of the Metrical scale for Barometers meets with a difficulty in the fact that maritime nations use the English scale almost universally. In this the unit is the inch, not, as in the Russian system, the half inch.

The remarks on the Barometer apply also to Rain, which I am convinced should be given, not in the cubic quantity of rain which falls, referred to a definite unit of area, but in depth. It is absolutely necessary to reduce, by melting it, the amount collected in a solid form to the liquid state. It seems to me, however, desirable to make a distinction between snow and rain in giving the quantity of rain.

4. For *storm signals* the adoption of a common system appears to me absolutely necessary, so that the sailor may expect the same language in all parts.

Whether only daily means or the observations of individual hours should be published, must be so entirely decided by the amount of means at disposal that no general arrangements can be made on the subject. The sole requirement which must be complied with is to calculate observations of the several hours to daily (five-day) and monthly means, as it is not fair to have to carry out these calculations when a journal comes to be discussed.

5. *Moisture* is to be given relatively and absolutely, *i.e.*, as per-centages of Saturation and by Tension of Vapour.

II.

Dr. J. Estreber, Director of the Statistical Department, Costa Rica.

Berlin, August 14th, 1872.

I see from the newspapers that, on the occasion of the meeting of the Naturforscher Versammlung in Leipzig, between the 12th and 18th, a conference is to be held, preliminary to the proposed International Congress, the object of which is the concentration of Meteorology.

The undersigned, who is Director of the Statistical Department in the republic of Costa Rica, in Central America, is at present resident in this country, being attached to an embassy from that state to Germany. On this account it is not possible for him to take part in the conference as he would have wished. In the progress of his statistical studies the subject of meteorology is constantly and fully brought before his notice, and he endeavours to prosecute inquiries in that science to the utmost extent that the resources of that small and young state allow him. He therefore thinks that it may not be unacceptable if he offers for the future to contribute his mite to the scientific results of the Congress.

The Isthmus of Costa Rica, across which an inter-oceanic railway is in process of construction, and where the preliminaries for the construction of a ship canal are in progress, is a region specially interesting and fruitful for meteorology, and there can be no doubt that the results of the Congress will tend to assist my modest efforts, and to direct them in the right path.

In the above sense I venture to take part in your proceedings by letter, and in my own name and that of my Government beg for the honour of a reply to inform me whether this my promise of co-operation can be recognized or not.

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III.

Sr. Fradesso da Silveira, Director of the Meteorological and Magnetical Observatory of the Infante Don Luiz, Lisbon, 5th August 1872.

Having received the invitation to attend the Meteorological Conference at Leipzig, which you have been good enough to send me, and being unable to take part in the meeting, I have the honour to forward you my opinion, and that of MM. de Brito-Capello and Gama Lobo, the heads of departments here, with respect to the questions which you wish to see placed on the programme of the International Congress to be held at Vienna in the autumn of 1873.

I shall follow your questions in detail:—

1. Doubtless. The Centigrade scale should be used for thermometers, the Metric scale for the barometer, the velocity of the wind, &c. But if this cannot be effected at once, at least the mean results, and the maxima and minima, should be referred to those scales in all publications. Uniformity of scales, p. 11.

2. Adie's (mercurial) barometer seems to us the most suitable. We adopt it for ships, and for the meteorological stations affiliated to the observatory, and only employ the aneroid to replace it temporarily, or for making comparisons at the moment of reading. Barometers, p. 13.

Stanley's aneroid might perhaps be suitable, but we are not yet sufficiently acquainted with it to venture a conscientious opinion about it.

3. They should be exposed to the free action of the wind from every direction, sheltered from the sun, rain, and radiation, and protected by double louvred screens. Exposure of thermometers, p. 14.

4. We prefer Negretti and Zambra's maximum, and Rutherford's (spirit) minimum. Maximum and minimum thermometers, p. 17.

5. The black-bulb maximum thermometer, in vacuo, for solar radiation, and for nocturnal radiation, the black-bulb minimum, in vacuo, placed in the focus of a parabolic mirror. Radiation, p. 19.

6. We cannot reply to this question from our own experience. Earth temperature, p. 19.

7. For a continuous series of observations we prefer the psychrometer. It seems to us that the hair-hygrometer, although improved, can never give precise indications in open air. Hygrometry, p. 34.

8. The winds should be denoted by the 16 rhumbs of 22° 30′ each, and the same figures or letters should be universally adopted. Direction of wind, pp. 36, 37.

In observatories of the first order, where the velocities are determined, Lambert's formula may be used for obtaining the mean direction, if the product of the winds' frequency by the corresponding velocities be substituted for the numbers indicating the frequency.

At stations of the second order the same formula may also be employed, if the product of the numbers which represent the frequency by those which represent the corresponding mean forces be introduced.

I think the error would be less if two forces denoted by zero, and of the same direction, were counted as one unit, than if they were neglected altogether.

9. A numerical scale, provided that the same scale is everywhere adopted. Scale of wind force, p. 38.

At stations of the second order we employ 8 degrees of force, denoted by the figures 0 to 7. (See our Report for 1871, p. 70.*)

10. The adoption of counting instruments would be very convenient. A simple and cheap anemometer should be used, to register the maximum force of wind in a given time. If this were done in every meteorological institute, the force of wind should be noted at the time of each observation at stations of the second order, and it should be represented by the well-known terms, "strong," "moderate," &c., or better still, by the figures of a generally adopted table. Velocity of wind, p. 39.

At the stations of the second order in Portugal we employ Robinson's anemometer, the scale being adapted for giving kilometres.

11. At the observatory we have the self-registering pluviometer, and one of Babinet's rain gauges at each station. We also use this rain gauge at the central observatory. Rain gauges p. 39.

We prefer the hour of 9 a.m. for reading the instrument.

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* Report for 1872, p. 70.

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Separation of rain from snow, p. 40.

12. Doubtless. It is only at some of our stations of the second order that we have to count the days of snow.

"Graupel" from hail, p. 40.

13. If possible. Too many details would perhaps be prejudicial, especially at stations of the second order.

Thunderstorms, p. 41.

14. The number of thunderstorms, and the number of days, should be separately counted.

Heat-lightning is always noted in the registers of the observatory.

Evaporation, p. 41.

15. Whatever vaporimeter is adopted, the same pattern must be established for all observatories and for all their stations.

It seems to us that it should be in the open air, exposed to rain, sun, &c.

The description of the form we have adopted will be found at p. 60 of our Report for 1871.

Proportion of cloud, p. 41.

16. In our opinion the convention of tenths of clear sky should be adopted for the amount of cloud. Thus 10 would signify clear sky, and 0 overcast. In any case a general convention is wanted.

It seems to us that the introduction of universal symbols would give great facilities. For instance, those found in the tables of Montsouris Observatory might be adopted.

Atmospheric electricity, p. 42.

17. Doubtless, in establishments of the first order. We have tried the continuously registering Electrometer. But unfortunately this instrument is not sufficiently perfected to merit complete confidence.

It is to be hoped, however, that an electrograph will give considerable results to science. We are inclined to believe it will.

Uniform times of observation, p. 20.

18. This is very desirable, but not easy at stations of the second order, where the staff is badly paid, or is not paid at all. The duties at such stations should be amalgamated with others, with schools, telegraphs, lighthouses, &c., in order to get a good organization. Then certain rules could be laid down, and their observance demanded.

Inspections and verifications, p. 23.

19. Certainly, but always in accordance with our reply to the 18th question.

Calculation of means, p. 25.

20. We think that observatories of the first order should calculate the means of the following elements daily, viz., Pressure, Temperature, Humidity, Velocity, and approximate Mean Direction of the Wind. For these and other elements means for decades, months, seasons, and the year should be calculated, noting the corresponding maxima and minima.

Mean values and resumés might also be calculated for five-day periods.

For the sake of uniformity we prefer to reckon the meteorological year from the 1st January. We actually do reckon it from the 1st of December.

Calculation of normal values, p. 28.

21. They must be deduced from the greatest possible number of observations, and since disturbances and the accidental variations of the different elements cannot be eliminated, we must determine the normal values from all these observations.

Uniformity of publications, p. 29.

22. Doubtless; but a common plan must be adopted for the publication.

Exchange of publications, p. 31.

23. By being transmitted post free, for the cost at present does not admit of a general exchange. If free transport is authorised by an international convention, three deliveries per month might be made.

Establishment of central offices, p. 31.

24. This service ought to be centralized, first in an observatory of the first order in each country, and then, if practicable, there ought to be an establishment which centralizes the works of different countries, to publish their general results.

Weather telegraphy, p. 32.

25. It appears to us that the exchange of meteorological telegrams becomes indispensable; but this interchange will not produce the results which might be expected, until all countries take suitable steps for preventing delay in the transmission of bulletins.

We often do not receive the Paris telegrams in time for the calculation of the probable weather for the morrow, which we publish daily in the official journal and in many other papers.

In the concession for the line from Lisbon to Brazil, by Madeira and St. Vincent, the Government has taken the requirements of meteorology into

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consideration, and has inserted in the concession our right to two telegrams per day, gratis, between these two points and Lisbon. Weather telegraphy.

We count upon similar conditions in every new concession. If, for example, a line is laid to the Azores, we shall have free meteorological telegrams. This advantage will enable us to render great services to meteorology, if Dr. Buys Ballot's plan is realized, as we think it will be, by the establishment of an important station on one of the islands of Corvo or Flores.

26. Those who conceived the happy idea of initiating the convocation of a preparatory meeting and the *savans* who will assist at the Vienna Congress will no doubt be able to obtain an International Convention to ensure the fulfilment of the decisions of the Congress. It is necessary to do so, for without that all our labours would end simply in a manifestation of our desires. Plans for Congress, p. 34.

The observatory of the Infante Don Luiz, for reasons which I need not discuss here, will probably have no representative at the Congress of Vienna.

If so, and I do not doubt it, I shall hasten to profit by the results of the Conference at Leipzig, to set forth the propositions which I consider indispensable to the success of an enterprise with which so many interests are allied.

Your set of questions, the publication of "Suggestions on a uniform System of Meteorological Observations," by Dr. Buys Ballot, Director of the Royal Meteorological Institute of the Netherlands, and the works of the Observatory of Paris, and several other establishments, for the Congress of Vienna, make it our duty to contribute as much as possible by placing at the disposal of the Congress all the elements which it may require and which depend on the special position of the Observatory of Lisbon.

IV.

M. Carl Fritsch, late Vice-director of the K.K. Central Anstalt für Meteorologie.

Salzburg, July 26th, 1872.

The numbers refer to the questions.

1. The introduction of similar units of scale for all meteorological measurements in all countries is certainly very desirable. Inasmuch, however, as such a general introduction will hardly ever be carried out, it is sufficient, or rather, it is unavoidable, to settle definite rules for the reduction of the measures in use. Uniformity of scales, p. 11.

2. The most suitable construction of barometers for stations of the second order is, in general, that which will admit of as rapid and certain a mode of determining the height of the column as is possible, without paying attention to extremely minute accuracy. Barometers, p. 13.

All reductions should be confined to that for the temperature of the mercury. A syphon barometer with rack work and a spring to move the scale, as at the Saxon stations, but without a microscope, is quite sufficient. I myself have formerly employed a similar instrument for years to my complete satisfaction. At the observatory organized by Kreil, at Prague, in 1839, the observations were at first made with this instrument. The use of aneroids at such stations cannot be sanctioned.

3. The best mode of exposure of thermometers for the determination of air temperature is in general to place them quite in the open air, and at a slight height, about two metres, above the ground. A cord or wire should be stretched between two posts, erected at a proper distance from each other, and the thermometer should hang from the centre of the wire. Exposure of thermometers, p. 14.

It is unavoidable, with such an exposure, that the thermometer should be exposed to rain and sunshine. If, however, the bulb of a thermometer graduated on glass is in the form of a cylinder of small diameter, the effect, either of evaporation of rain water, or of insolation, is slight, and, moreover, compensates itself, at least in some measure. At all events the disturbing influences, with such an exposure, would be less than with any other near a building, whether sheltered by a screen or not.

Such a mode of exposure should be at least introduced at all central observatories, which are almost always in a position to provide the necessary sites,

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even though it cannot be recommended for general adoption in respect of the last-named condition. I can cite Lamont to confirm my views.*

Maximum and minimum thermometers, p. 17.

4. Walferdin's maximum thermometer, and Baudin's minimum thermometer, seem to me the best to be recommended for general use in determining the absolute extremes of temperature.

Earth temperatures, p. 19.

6. For the determination of earth temperatures, I prefer the arrangement which admits of the use of thermometers of ordinary dimensions, which can, therefore, be sunk into the soil at pleasure and withdrawn again. The apparatus used by Lamont appears to me quite suitable.

The successive depths at which the temperature is determined should extend to the stratum of constant temperature, and may be increased in a certain proportion according as that is approached.

Hygrometry, p. 34.

7. In my opinion the psychrometer is sufficient for the determination of the hygrometric state of the atmosphere, and is certainly preferable to the hair hygrometer.

I consider that the keeping the wet bulb constantly wet, or rather the confidence of the observer on that point, which is usually excessive, is the chief source of error. I therefore recommend wetting the bulb before each observation, as is at all events a matter of course in winter, about a quarter or half an hour before each observation.

Direction of wind, pp. 36, 37.

8. On this head I refer to my remarks, on § 1. It might be well to limit the directions to the eight principal points, N., N.E., E., S.E., &c. The deduction of the mean direction of wind by Lambert's formula seems to me desirable in all cases where we have to deal with summarized results and slight changes in direction of the wind. Its employment in the representation of the diurnal period of the wind's direction would be of great use.

The very light winds should also be regarded in the distribution of the directions in the windrose, as a definite limit can hardly be given for the force.

Scale of wind force, p. 38.

9. Where a simple estimation of the force of the wind is given, a scale with few divisions is sufficient, and this is therefore all that needs confirmation. I am, however, for the retention of the scale of 10, because it has been used generally and for a long time.

Velocity of wind, p. 39.

10. I hold the introduction of a simple counting apparatus for determining the velocity of the wind as very desirable, and I should be still more pleased if it could entirely replace the arbitrary, and therefore hardly intercomparable, estimation of the force (Question 9).

The distance in metres traversed by the wind in a second might be taken as the unit for velocity.

Rain gauges, p. 39.

11. The rain gauges used by the Central Anstalt in Vienna seem to me quite suitable. I should only recommend that the receiving vessels should be provided with handles and that two receiving vessels, or still better, two complete gauges, should be issued to each station, which could be interchanged on days of fall, or also in the interval between two measurements, with unusually heavy or continuous falls, which would cause anxiety lest the gauge should not be large enough to hold the entire quantity which has fallen. This is not an uncommon occurrence with snow, and it also not unfrequently happens that a part of the fall remains in the receiving vessel, in the form of snow or hail, while the remainder is in the collecting vessel, in the form of water which arises from a thaw, or from rain which fell at the same time. On the whole, it is possible that no insignificant amounts of rain may be lost in the course of the year, by manipulation at the time of measurement, if one has only a single instrument to deal with and cannot put another in its place. The junction of the collector with the receiver should be quite water-tight for certain very heavy falls (*wolkenbrüche*), in order that the water which falls, over and above the full of the collector, may at least remain in the gauge.

Of my two gauges exposed at the same time, that with a square aperture constantly gives greater quantities than that with a cylindrical aperture. The receiving area of the former is, however, only about quarter of that of the latter.

For the time of measurement I recommend noon, as it chances to come at the time of least fall, at least in summer, and has some relation to the divi-

* Jahresbericht der Kön. Sternwarte bei München. 1852.

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sion of time, as the astronomers begin the new day at that hour. I should certainly prefer midnight if the hour were not too inconvenient.

12. I should not distinguish between the days of rain and snow, or if that be done, should always give the number of days on which a fall occurred, for then you have a safe check in the rain gauge, and because it is in many cases difficult to separate the days of snow from those of rain. If, however, the nature of the fall is given, in the way adopted at the Central Anstalt in Vienna, all requirements are met. Separation of rain from snow, p. 40.

13. I consider the separation of the falls of hail from those of "*graupel*" still more difficult. "*Graupel*" consists of balls of snow, and, as such, is almost always found as the nucleus of the hailstone, which has a shell of ice. This latter may, however, be infinitely thin in many cases. Separation of "graupel" from hail, p. 40.

We know also that hail falls principally in summer, "*graupel*" in the spring months. If in addition we remember that, in winter, snow-"*gries*" falls, the smallest form of "graupel," we can no longer hesitate to consider all these forms as simply different modifications of a definite form of precipitate.

14. I consider the enumeration of the thunderstorms, as such, as impracticable, and I succeeded in carrying my point on this subject at the Statistical Congress at Vienna in 1859. It would be nearly the same thing as trying to count the number of gusts of wind. Thunderstorms, p. 41.

When does one storm end and another begin? On a day with constant rain it lightens and thunders at intervals for an hour together; how many storms are there? A storm in one place produces another elsewhere, and so forth; one of them is therefore near to, and the other at a distance from, the same station; should both be counted? Should all the storms be counted which occur on a hot summer's day, at a greater or less distance from the observer, and either simultaneously or successively in an isolated rain-cloud?

How different will be the result of counting at two stations not far asunder, which ought to agree with each other approximately in their numbers. What phenomenon is to be taken in all cases as the beginning or end of a thunderstorm?

On the contrary, how easy and definite is the counting of the days of storm. It is enough to have had one observation, of either lightning or thunder, to put down the day as a storm day. If more minuteness is required it would be better to count the hours of thunderstorm on each day, or even the electrical explosions themselves.

I think it just as difficult to separate the days of sheet lightning from those of thunderstorms; in the overwhelming majority of cases, though not invariably, sheet lightning is a thunderstorm at a distance.

15. For the measurement I recommend a vessel similar to the rain gauge but shallower, and with this difference, that the receiver is furnished with a cock, in order to measure the residual water in the measuring glass of the rain gauge. It should not be protected from sun and rain, but we should provide against the influence of insolation, in undue heating of the immediate vicinity, and should take care that the actual amount of rain, to be subtracted at the time of measurement, should fall into the vaporimeter. Schenzl at Ofen and Prettner at Klagenfurt use a vaporimeter of this kind. Evaporation, p. 41.

16. The greatest trouble, in the estimation of the amount of sky covered, is given by the *cirri*, which generally cover a great part of the sky, and yet are so thin that, when the sun is behind them, only a slight diminution of insolation is produced, and very rarely is this quite intercepted. Proportion of cloud, p. 41.

Inasmuch as practically they are only estimated according to their true extent in the latter case, at least when there are no other denser strata of clouds to be noticed, they should only be regarded at all whenever the last-named phenomena occurs, which is certainly very rarely.

There are similar difficulties with ground fogs, which are often so dense that, when the sky is otherwise clear, the sun and moon are obscured. The difficulty is still greater when this fog is in the act of dispersion and the blue sky shines through it. *Cirrus* and *stratus* should be therefore entirely disregarded in the estimation, but might be noticed, as observations in the journal, instead of the amount of sky covered.

It would certainly be best of all if photometric measurements enabled us to dispense with the estimation of the proportion of sky covered.

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Proportion of cloud, &c., p. 41.

I should vote for the introduction of generally understood designations for the clouds, hydrometeors, and thunderstorms, if there were any prospect of their general adoption. If not, I recommend the designations employed at the Central Anstalt in Vienna, which were adopted at my suggestion.

Other extraordinary phenomena should be excluded from these rules of nomenclature, and in this respect freedom should be allowed to each observer.

Extra observations, p. 42.

17. I should wish to apply the last remark to this question also.

Uniform times of observations, p. 20.

18. I fear that the introduction of uniform periods of observation, if that means similar hours of observation, would meet with great difficulties, and would bring about the result of a diminution of the number of observers.

Inasmuch as the methods appear sufficient to reduce the observations, at least in the mean values, to similar times, it hardly appears necessary to aim at such uniformity.

The question is different if individual dates of observation are to be compared. In such cases similar terms of observation would be certainly very desirable. However, among a great number of stations, we can always find groups with similar hours.

Inspections and verifications, p. 23.

19. The verification of instruments and the inspection of stations should be considered as pertaining to the internal management of the respective central observatories.

Calculation of means, p. 25.

20. The mean values of the several meteorological elements should always be reduced to 24 hourly or true means. In the publications, however, the method must be explained in detail, in order to afford subsequent investigators the necessary opportunities for improvements, as far as the prospects of perfecting the methods of reduction will allow.

The monthly and yearly periods can hardly now be given up. It is another question, whether or not daily means are preferable to five-day means.

If no means are deduced for the separate seasons, the year should begin with January 1st, if the contrary be the case, with December 1st.

Calculation of normal values, p. 28.

21. All that has just been said is of even greater weight as regards the normal values, which should be calculated every five, or better every ten, years, or may be improved in certain respects.

Uniformity of publication, p. 29.

22. The publication of the meteorological observations of a limited number of stations in each country on a uniform plan, and within a comparatively short time, I think possible, but not desirable, apart from special objects.

Exchange of publications, p. 31.

23. The exchange of meteorological publications of different institutions and different countries will be conducted most simply and safely, if not always most cheaply, by the post.

Establishment of central offices, p. 31.

24. It is desirable that one, and even several, central stations should be established in each country for the management, collection, and publication of meteorological observations; but above all things care must be taken to have men fit to take charge of such establishments.

Weather telegraphy, p. 32.

25. A more extensive development and more settled organization for the exchange of weather telegrams seems undesirable, judging from the results already attained, at least in the countries at a distance from the sea.

Plans for Congress, p. 34.

26. The directors of all the central institutes should be requested to carry out the resolutions and the ideas of a Meteorological Congress.

V.

Dr. H. Hildebrandsson, Professor at Upsala.

Upsala, August 1872.

As I am unfortunately prevented from attending the Meteorological Congress at Leipzig, I cannot but comply with the wishes of the gentlemen who have issued the invitation, and therefore indicate briefly a few questions which I consider worth the attention of the International Congress.

Modern meteorology may be divided into four great branches. 1. The Meteorology of the Sea. 2. Climatology, including the theory of the instruments and the study of the regular Periodic Variations. 3. The Non-Periodic

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Variations, or the general disturbances of the atmosphere, with their practical consequences; Storm Warnings and Weather Prophecies. 4. The non-instrumental observations, viz., those of phenological phenomena, of thunderstorms, of ice, of frosts, &c.

The first branch does not appear, from the invitation, to be brought into special notice. The brilliant results to which the uniform system introduced at the Brussels International Congress has led, appear to be a strong inducement to introduce a uniform system in other inquiries relating to meteorology.

On the other hand, most of the questions which have been proposed belong to the second branch, and the greater part of Dr. Buys Ballot's "Suggestions on a Uniform System of Meteorological Observations" treats of matters connected therewith. On this point I would only add one remark. It would doubtless be best if the same units of scale and the same instruments were used in all meteorological measurements; probably, however, such an arrangement would be fraught with great difficulties. Even if we might hope that national vanity, as a thing unworthy of men of science, would not come into consideration, yet among other matters it is a money question of no small importance to change all the instruments for others.

If, however, we suppose that such a uniformity in measures and instruments could be attained, an exact comparison of the observations of different countries would be very difficult, partly owing to the dissimilarity in the standard instruments, partly owing to the local conditions and situation of the stations. I would therefore propose the following proposition for the consideration of meteorologists:—

Would it not be of importance to nominate an international commission, with instructions to compare the normal instruments at the central establishments and the most important observatories in the various countries, and to determine definite rules for the reduction of the measures, scales, and nomenclature adopted in various countries?

The third branch of meteorology, or the study of the General Movements of the Atmosphere by means of simultaneous observations over as large a part of the earth as is possible, is without doubt that which presents the most important subjects for consideration to a congress of meteorologists. It is *only* by the combination of the efforts of all that the most important results can be attained.

Much has already been done in Paris. M. Marié-Davy has himself lately insisted on the necessity of further perfecting of the synoptical charts. In America synoptical charts are published three times a day, under the direction of Brigadier-General Myer. *If the same were done for Europe and the entire Russian empire, in Paris and St. Petersburg, a great step would have been made towards the solution of the most important theoretical and practical problems of our science, and Le Verrier's great plan would have been carried out.*

But the synoptical charts alone are certainly insufficient; they must be accompanied by observations of all the instruments. In this respect Question 22 of the invitation seems to us of the greatest importance. Buys Ballot has proved, by the admirable representations in his Jaarboek, that it is "useful and possible to publish the meteorological observations of a limited number of stations in each country in a uniform style and within a comparatively short time." *An enlargement of this admirable publication appears to us the easiest solution of this problem.*

For the study of storms, however, the records of self-registering instruments are of special importance. They afford us the means of recognizing the individual details of a disturbance of which the synoptic chart gives the general view. I have lately endeavoured to investigate this question in a small paper, "Etudes sur quelques Tempêtes," Gottenburg, 1872. The magnificent publications in the London Quarterly Weather Report are of prime importance in this respect, but unfortunately they only embrace British stations. If we had such graphical representations from the continent also, there is no doubt that we could study the changes in the atmosphere more thoroughly than by means of the synoptic charts alone. I ask, therefore, *Is it desirable and possible, in addition to the daily synoptic charts, to obtain also a graphical representation of the course of all the registering instruments at* 10 *or* 12 *stations in Europe daily, and in a short time after the observations?*

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Let us now proceed to the fourth branch. The invitation has not included any question bearing on it. Such investigations are, however, carried out in many countries, and results of the greatest importance are being attained. These studies are carried on at a comparatively trivial cost, and they have the invaluable advantage of spreading in wider circles the interest for inquiries bearing on natural science. In many countries, especially in Austria and Belgium, phenological observations, of the highest scientific and practical value, have been instituted for a long period. In France and Norway the observations of thunderstorms have led to unexpected results. In Sweden also about 300 observers are engaged in recording the Ice conditions, Thunderstorms, and injurious Frosts. At our suggestion the Agricultural Association has named the observers in each province, and these are now in immediate relations with this observatory. The results of the Ice observations in the winter of 1870–71 are already published, and the Thunderstorm observations of the previous summer are now in process of discussion. How much greater and more comprehensive would the results be if such inquiries could be carried out in common over whole quarters of the globe. I venture, therefore, to propose the following questions to the Congress:

Is it of importance to organize in all civilised countries stations of the third order, without instruments?

If so, what observations should be made at these stations?

Is it desirable that different classes of these observations should be discussed and published at different central stations?

VI.

Capt. Hoffmeyer, Director of the Meteorological Institute, Copenhagen, to Director C. Bruhns, in Leipzig.

Copenhagen, August 9th, 1872.

I have to thank you for the kind invitation to the preliminary Meteorological Conference in Leipzig which I have received. I am unfortunately obliged to tell you that it will not be possible for me to leave Copenhagen.

The numerous arrangements which have to be made in connexion with the organization of the meteorological system in this country, and especially the testing of the different instruments which is now in progress, will not allow me to quit my post.

At the end of your invitation you have requested me to send in communications in writing, and so I allow myself to append notes on some of the questions proposed by you:—

Uniformity of scales, p. 11.

1. We use only millimetres and Celsius.

Barometers, p. 13.

2. For stations of the second order we have arranged to employ Kapeller's station barometers, and aneroids are not used.

Exposure of thermometers, p. 14.

3. The thermometers are set up in a wooden louvred screen facing north.

Maximum and minimum thermometers, p. 17.

4. We hope to get maximum and minimum thermometers from Geissler, in Berlin.

Earth temperature, p. 19.

6. We intend to try experiments with Regnault's new air thermometer (silver capillary tubes).

Hygrometry, p. 34.

7. Although observations with wet and dry bulb thermometers are much influenced by local and other circumstances, we know of no better arrangements for stations of the second order.

Direction of wind, pp. 36, 37.

8. In my opinion very light winds had best be disregarded, because the observer is often led astray by the vane in such cases.

I do not think Lambert's formula satisfactory on the whole; at least the force must be taken into consideration therewith.

Scale of wind force, p. 38.

9. The scale 0–6 is the easiest for an observer to understand, but it must be understood that the force 6 virtually never occurs with us.

Wind velocity, p. 39.

10. We are thinking of introducing a simple apparatus for the measurement of wind force at stations of the second order, mainly consisting of a disc which

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turns about a horizontal axis. By this means the indications of the several stations are at least intercomparable.

But what velocity will correspond to force 6 of the above scale?

11. An original, very simple, and durable rain gauge has been constructed here by Hr. Docent Fjord after a series of accurate experiments lasting many years. With its stand it costs only 9*s*. Rain gauges, p. 39.

What is, however, the best form of snow gauge?

15. At the instance of the sub-director of our institute, Hr. P. La Cour, rational experiments on evaporation are being carried on. At present I shall only allude to the importance of recording the temperature of the vaporimeter. Evaporation, p. 41.

16. Universally intelligible symbols appear to me very desirable. Proportion of cloud, p. 41.

17. The observation of the motion of cirrus clouds is certainly of extraordinary importance. Extra observations, p. 42.

20. The division of the year (Dec.–Dec.) into 12 periods of 30 or 31 days, and of these periods into five-day intervals, of which some contain six days, which Buys Ballot adopts in his Jaarboek, seems to me exact enough and suitable. Calculation of means, p. 25.

22. This is certainly of great importance, because it makes it possible to discuss recent meteorological occurrences, and also the general character of the weather in adjacent countries, and thereby increases the interest of the public, as well as adding zest to the labours of the scientific man. Uniformity of publications, p. 29.

The monthly observations of our stations will be published if possible on the 15th of the following month.

25. The weather telegrams will soon be as necessary for sailors and farmers as Exchange telegrams are now for commercial men. A better distribution of the stations, a firmer international organization, and above all things a more certain and rapid transmission of the despatches by wire, would be very desirable. Weather telegraphy, p. 33.

In an international organization the difference of local time must be considered (as is already the case in North America).

I add further:—

1. On our thermometers 95° is engraved instead of—5°, 90° instead of—10°, &c., in order that the observer may always read from below. Many errors are certainly avoided hereby.

2. Stations of the third order appear to me very necessary. The choice of stations of the second order is often determined by circumstances other than those which are purely meteorological (such as the proximity of a telegraph station, the existence of a skilled half-volunteer observer, &c.) Hereby it is not unusual to find the wind conditions somewhat disturbed, at times also the temperature and rainfall. Stations of the third order (without barometer or psychrometer) can be established much more easily at stations where the meteorological conditions are less local.

VII.

Engineer Lauterburg, formerly Chief of the Central Hydrometrical Bureau of Switzerland.

Berne, August 8th, 1872.

You have honoured the undersigned with a circular invitation to the European Meteorological Conference in Leipzig, and have thereby laid on him the obligation of returning you his sincere thanks for your kind attention.

In thanking you I must first of all express my great satisfaction that an attempt is at last to be made to carry out a uniform and systematic procedure in the organization of meteorological observations, although I myself have never *personally* engaged in meteorology, because I was only in the position of *turning to account* the results of meteorological observations in various branches of science and art, of theoretical and practical importance (such as drainage and hydraulic engineering).

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As the undersigned could not hope to contribute material direct assistance to the Conference by his attendance at it, it will afford him the greater pleasure to be able to assist it indirectly to the extent of his power, inasmuch as he will urge on the Government all the suggestions which may be addressed by the Conference to his countrymen, in his capacity of member of the Swiss Naturforschende Gesellschaft, at its meeting at Freiburg, August 19–21, as well as in virtue of his former presidency of the Central Hydrometrical Bureau. Although in consequence of a great increase of work he has had to hand over to the Swiss Inspector of Works, with a large collection of charts and views, the hydrometrical functions which he had called into existence and organized in Switzerland seven years ago, his influence with the Federal Officials in regard of this branch of investigation, immediately dependent on meteorology, is by no means at an end.

In order to give the Conference in a few words some idea of the mode of application of one of the chief results of meteorological observations, viz., the rainfall, I enclose a copy of a River formula ("Stromverbal") for one of the small rapid mountain streams. The data which have been taken from the meteorological observations refer to articles 7, 8, and 9.

In the same way the undersigned has calculated the mean minimum and maximum volumes of all the Swiss rivers of the first, second, and third rank, and published them in comparison with the immediate results of current measurement in a small pamphlet sent herewith. The method in which the main factors of the rainfall have been deduced in it shall, if possible, be explained in a subsequent pamphlet.

VIII.

Dr. H. Mohn, Director of the Royal Meteorological Institute of Norway at Christiania.

Bergen, August 1st, 1872.

When I received the circular with the invitation to the Meteorological Conference of this year in Leipzig, I had already arranged my tour of inspection of the meteorological stations for the year, and I could not think of going to Leipzig, however much I should have wished to do so.

Now that I am on my tour I have not leisure enough to devote such a thorough consideration to the Meteorological Conference as I should otherwise have given to it. However to show my interest for this question, which is of such universal importance, I allow myself to express in a few words my views on several of the questions proposed in the circular.

Uniformity of scales, p. 11.

1. Metrical scale and Celsius degrees everywhere; no reduction.

Barometers, p. 13.

2. Aneroid barometers are *not* to be used for fixed stations.

Exposure of thermometers, p. 14.

3. Something like that introduced in Scotland. In this country the thermometers at the telegraph stations must be set up outside the window of the office, else the telegraph staff could take no observations.

Hygrometry, p. 34.

7. For the observer the psychrometer is the most convenient. In severe cold the hair hygrometer must be used with it. The convenience of the observers is an important point to be considered, in order to obtain trustworthy observations. We could obtain no results with complicated hygrometers. The psychrometer is certainly untrustworthy in cold (below $-20°C$) and in strong winds. We shall obtain from Russia information as to the value of the hair hygrometer in such cases.

Direction of wind, pp. 36, 37.

8. By the English initials, no numbers. Lambert's formula should not be used. The force 0 should not be included.

Scale of wind force, p. 38.

9. Numbers 0–6, the half of the Beaufort scale. A small anemometer, something like a plate moving round a horizontal axis, would render good service for measuring the force, and ensuring uniformity in measurement.

Velocity of wind, p. 39.

10. Good in open localities. Kilometres per hour.

Rain gauges, p. 39.

11. Not heavy, for the observers will not bring heavy masses of snow into the houses. It would be best to make the measurement after each fall, and in the mornings. At our Arctic stations the measurement of snow is often quite

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impossible and illusory. The snow flakes do not fall into the rain gauge, or else the snow which has already fallen is drifted by the wind, and mixed with that which is falling subsequently.

12. I have separated them. Separation of rain from snow, p. 40.

14. I have tried both methods. Perhaps it is enough to count the days. Sheet lightning separately. Thunderstorms, p. 41.

15. No experience. Evaporation, p. 41.

16. Blue sky = 0, overcast = 10. Symbols would be very convenient. Proportion of cloud, p. 41.

17. The so-called atmospheric electricity belongs as yet to Physics. Extra observations, p. 42.

18. The time of observation must be arranged according to the convenience of the observers. Uniform times of observation, p. 20.

19. With difficulty. Inspections and verifications, p. 33.

20, 21. The length of the intervals depends on the working power of the institute charged with the reduction. Monthly means should be set in the first place as regards importance, and should always be given. The method of calculation depends on so many circumstances that it can hardly be discussed unless verbally. Calculation of means, p. 25.

22. According to my experience, yes. Uniformity of publication, p. 29.

23. Printed observations which are not collected by telegraph, by book post every month. Exchange of publication, p. 31.

24. Yes. They exist in almost all countries of Europe. Establishment of central offices, p. 31.

25. Yes. Especially for storm warnings. Weather telegraphy, p. 32.

I shall be extremely interested, on my return to Christiania, which will be about September, to learn the conclusions at which the Meteorological Conference at Leipzig has arrived, and I venture to tender to the Conference my heartiest wishes for the completion of its arduous tasks, and to present my best compliments to my honoured colleagues who attend it.

IX.

Letter from Sanitäts-rath Dr. A. Mühry at Gottingen.

July 1872.

I recommend to the Meteorological Conference five meteorological questions which seem to merit general consideration.

1. The *general storms of Europe*, which usually occur five or six times a year, especially in winter, and travel from the westward, *i.e.* in the Antipolar Current, seem, in respect of their character, extent, and direction, to be only capable of becoming generally known by means of systematic observations carried out on a uniform system for at least some years.

2. The *temperature of the soil* has been sufficiently ascertained only in the middle latitudes; but in order to establish the theory, comparable observations are wanted in the Torrid and the Frigid Zones. A few years' observations, conducted on a uniform system, are required.

3. The *temperature of lakes* in depth is scarcely known, except in the neighbourhood of the Alps, and here too, hardly in winter; besides, it has been determined in a few of the Arctic lakes.

It would be desirable, for the theory, to determine the temperature, in depth, of a lake near the Equator, where it probably would hardly differ from the surface temperature.

Moreover there is a want of investigation of the temperature of salt lakes, with at least 3·3 per cent. of saline contents, in order to be able to decide by experiment if their behaviour is the same as that of fresh-water lakes, and to make use of the results for the theory of the conditions of temperature of the ocean.

4. The modern, if we may so term it, *the intuitive meteorology*, must wish, that in the arrangement of the reports of the observations which have been made, care were taken by means of combination (comparison) of the separate

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elements to facilitate the attainment of a general comprehensive view of the meteorological conditions as a whole, so as to be able over the whole extent of Europe to recognize and trace out the simultaneous positions of the Trade Winds, and the changes which they undergo.

5. The choice of localities on the earth's surface suited for the *astronomers* to observe the *transit of Venus* in 1874 would be worth consideration from a meteorological point of view, in order to ensure the result, by avoiding a climatic cloud covering.

X.

Letter from M. Cecilio Pujazon, Director of the Marine Observatory at San Fernando, to Director Bruhns.

San Fernando, August 7th, 1872.

Contrary to my wishes, it is impossible for me to attend the Meteorological Conference in Leipzig, but I hope to be able to travel to Vienna next year, and I shall be very glad to take part in the Congress there.

Meanwhile I am ready to adopt all the conclusions of the Leipzig Conference, inasmuch as it is only by unanimity and uniformity in all our investigations that any progress can be made in meteorology.

XI.

Letter from Prof. Ragona, Director of the Royal Observatory at Modena, to Director Jelinek.

Modena, October 7th, 1872.*

At the meeting of August 14th I greeted the first International Meteorological Conference, and recommended to the Congress two points for consideration for the advancement of the science.

The first bears on the influence which the Congress should exert on such European powers as have not yet established a central physical observatory or a meteorological institute, in order that the deficiency which exists might be supplied according to a plan suited to the conditions of the locality, and which should be proposed by a commission appointed for the purpose.

The second matter concerns the publication of a compendious Handbook and Text book of Meteorology, a real encyclopædia of meteorological science.

As this work should represent the latest position of meteorology, down to the most special details, on the basis of the discussion and calculation of the most important observations carried on over the whole surface of the globe, so that it should serve as a point of departure for future inquiries, and as a scientific basis for future labours, it is self-evident that a treatise so copious would exceed the powers of a single author. The duty of sketching out the general plan and the division of the work should be entrusted to a special commission, and then the most eminent meteorologists of the old and new world should be invited to take part in the editing of the respective subdivisions.

Barometers, p. 18.

2. With reference to aneroid barometers, my opinion, based on a long series of observations, the results of which I published in Secchi's "Bullettino Meteorologico," is to the effect that this instrument can only replace the mercurial barometer, and serve for the determination of barometrical maxima and minima, when it remains constantly at the same observatory, and when the corrections depending on the temperature and the condition of the aneroid

* Professor Ragona, who took part in the preliminary conference at Leipzig, has by letter expressed his wish that his remarks should be expressed at somewhat greater length, and moreover he has treated some of the questions of the programme more fully. It did not appear possible to introduce his letter into the report, without making an exception to the uniform treatment to which the views of the respective speakers were necessarily subjected, and so the wishes of Professor Ragona are met by introducing his letter in this place.

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have been accurately determined. The corrections of the aneroid are liable to change if it be moved from place to place, so that at each new locality a fresh accurate comparison and determination is required; so that in its present form the aneroid cannot be recommended as a substitute for the mercurial barometer not even for meteorological stations of the second order.

3. In respect of the exposure of thermometers, I draw a distinction between that in an open place exposed to the sun (as in a garden or on an open terrace), and the exposure usual in Italy in a sufficiently large window of a high building and facing North. In the latter case I recommend the system which I employ, the description of which is already published, and which has proved satisfactory in practice. Exposure of thermometers, p. 14.

In order to shelter the thermometers from the influence of the sun's rays, of the rain, and radiant heat, &c., I recommend that only such means as are absolutely necessary should be employed, and I object to all other arrangements, such as double or triple louvres and roofs. I must also state that I object to all arrangements which alter the thermometrical condition of the air, such as the employment of artificial currents of air, produced by aspiration or pressure. The temperatures obtained by all such means are artificial, and may differ materially from the real temperature of the air.

I am convinced of the importance of some movement in the air near the thermometer, in order to remove the film of air which adheres to the instrument, but I prefer, to the rotation of the thermometer, a slight movement of the air, which is produced at the Italian stations by a fan.

4. I consider as the main condition for trustworthy results from the maximum and minimum thermometers that the instruments in question should be placed as near as possible to the thermometer intended for the observation of the temperature of the air at every observation. Maximum and minimum thermometers, p. 17.

As the temperature of the air from time to time, as well as the maximum and minimum, are only expressions of the changes which the same phenomenon undergoes in a definite period, it is easily seen that, if these changes are observed on instruments situated in different strata of the atmosphere, such observations will not admit of a strict comparison, as has already been shown, by direct experiment, both by Lamont and myself.

From this point of view, the old maximum and minimum thermometer of Bellani might be recommended, because that in order to determine the air temperature by it you read, on the scales, the level of the liquid columns instead of the position of the indices. It has, however, gone out of use because it does not bear carriage well, and easily gets out of order in other ways. I am, however, of opinion that science would gain if Bellani's instrument could be improved, and substituted for the dry thermometer in the psychrometer (as is done by the Tecnomasio Italiano).

In this case you could obtain from the same instrument, of which the thermometer bulbs are very close together, and are therefore situated in the same stratum of the atmosphere, the data for air temperature, vapour tension, humidity, and the extremes of temperature.

5. For the determination of the temperature of insolation I recommend an instrument proposed by me in the year 1862, at the Polytechnic Association in Turin. It consists mainly of a heliostat with clock work, which carries a maximum thermometer of Negretti and Zambra's constantly at right angles to the incident rays of the sun from sunrise to sunset. Such an instrument must of course be set up in a locality which is perfectly open and exposed to the sun's rays at all times of the day. Radiation, p. 19.

7. For the determination of the moisture of the air I most warmly recommend the psychrometer constructed by the Tecnomasio Italiano in Milan, and I would point attention to the observations of Belli and Cantoni, which show that false results are obtained, if psychrometers of other constructions are employed, especially thermometers with spherical bulbs, covered with linen, and moistened by a thread constantly dipping in water. Hygrometry, p. 34.

With reference to the hair hygrometer, I can prove by the experiments instituted by me and published in Secchi's "Bullettino Meteorologico," that this instrument gives quite as good results as the best psychrometer, if its corrections be first accurately determined, by comparison with the psychrometer.

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Moreover the hair hygrometer may be arranged as a self-registering instrument by employing a bundle of 30 or 40 hairs.

It is a great advantage to enclose the hygrometer in a screen of the finest wire gauze.

Wind, pp. 36 37, 38, 39.

8, 9, 10. Lambert's formula in its original form is useful even for observatories of the first order, as it leads to the recognition of special principles, the investigation of which bring instructive and useful results to light.

At all events it would be very desirable that cheap anemometers should be made, which should give the wind in kilometres per hour, could be easily fitted, and should meet the requirements of a meteorological station of the second order.

The present use of the wind scale, as we find it at most of the smaller observatories, is as untrustworthy as the determination of temperature by means of thermometers exposed at different places.

Each observer describes the wind which appears to him strongest, by the highest figure of the scale; but the intensity of this wind is very variable in different localities. The strongest wind felt in a town in central Europe is not the strongest wind which occurs in an island in the West Indies. If *e.g.* a scale of 8 parts (0–7) be made the basis, it may easily happen that the wind described as 7 may mean for one observer a velocity of 60, for another one of 80 kilometres.

Rain gauges, p. 39.

11. In the Royal Observatory at Modena the measurement of the rainfall, &c., is made at midnight in order to ensure uniformity with the civil reckoning.

In cases of heavy falls the collecting vessel is frequently emptied, but only the sum of the amounts registered is entered in the register.

In addition, the beginning and end of the rain, as well as its intensity, are registered by the pluviometer, which records by electricity.

Evaporation, p. 41.

13. In respect of evaporation I can refer to numerous experiments which I have made on the subject. I recommend for adoption my method of observation, which consists of two vaporimeters of equal areas erected at different heights, of which one is in the open air, the other is at the north window of the observatory (the *finestra Meteorologica* of the Italians). The observation of the lower vaporimeter is always possible, while that of the upper one may often be vitiated by wind, rain, and other agencies. On suitable days comparative observations are instituted between the two instruments, which serve for the determination of the factor for reducing the lower instrument to the upper one.

I can recommend for use the vaporimeter made at the Tecnomasio Italiano in Milan, and, wherever a greater outlay is not an objection, the self-registering vaporimeter invented by myself.

Extra observations, p. 42.

17. The observation of atmospheric electricity seems very desirable, and it would be well to introduce it at a greater number of stations.

I recommend, as an observing instrument, Palmieri's Bifilar Electrometer, with the improvements introduced by me.

However it is to be wished that the self-registering electrometer may soon be so far improved as to be capable of more general adoption.

Uniform times of observation, p. 20.

18. It is very difficult, even in smaller systems of observation, to ensure uniformity in the hours of observation.

It will therefore be necessary to disregard this uniformity altogether, and rather to aim at obtaining the uniformity by reductions, which may be easily obtained from the normal values known for the separate stations. Hence follows the necessity of the establishment of a central observatory in each country, the duty of which should be to determine the normal values for the separate stations by differences which should be based on observations of such stations as have a long-continued and accurate series.

Calculation of means, p. 25.

20, 21. I am of opinion that the meteorological year should begin with December, and be divided into four periods of three months each, inasmuch as it does not seem right to begin a series with a maximum or a minimum, and, by the mode of division proposed, the maximum and minimum as well as the mean temperature will fall in the middle of each period.

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The means may be calculated for decades, months, seasons, and years, but yet I recommend especially the calculation of five-day means, whereby the system introduced by Dove should be used for all stations and without deviation.

On the other hand, the five-day means which begin with each month, such as are given by some observatories, should be rejected, as there are always irregularities, with the last of these means, in regard of the number of days, as it may consist of three, four, five, or six days. Such means have no value, and cannot be compared with Dove's five-day means.

22–24. With reference to the question as to the establishment of meteorological central observatories in every country, and the publication of meteorological observations, which should be carried out as rapidly and completely as possible, I refer to my remarks at the commencement, and I consider the utility of such institutions so evident that it makes all discussion of the subject superfluous. Organizations, pp. 29, 31.

XII.

Professor R. Rubenson to the Meteorological Conference at Leipzig.

Upsala, August 1872.

The writer of these lines, being prevented from taking part in the Meteorological Conference at Leipzig on the 14–16 August this year, and having a sincere conviction of the importance of all measures, the aim of which is to bring about a greater degree of uniformity in the meteorological labours of different countries, and a more unanimous agreement on the principal questions of the science than has been the case hitherto; takes the liberty of responding to the request made to meteorologists to communicate, if only in writing, their ideas on the easiest and surest means of attaining the end desired.

1. Whoever follows attentively the ever-increasing literature of meteorology cannot fail to perceive that works bearing on the meteorology of limited districts are in reality those which pretend to the greatest accuracy, while works of a more general grasp become less sure in proportion as the district to which they refer becomes more extended. Up to a certain point it is in the nature of things that this should be the case; greater exactitude ought evidently to be attainable in the comparison between neighbouring localities, which necessarily present less differences in a climatological point of view, than when the distribution of a meteorological element is studied over a larger area. But while admitting that it should be so to a certain extent, it by no means follows that the result of an investigation on a more extended scale cannot be made relatively quite as certain as that of a limited region. In other words, the uncertainty of the quantitative data ought, even in this case, to lie within predetermined limits, depending on the nature of the problems which the general investigations in question are called upon to solve. Now, if we examine the results arrived at in the investigations of whole portions of the globe, and *á fortiori* of the entire northern hemisphere, and if we inquire, for instance, with regard to the temperature, the height of the barometer, the wind and rainfall, what degree of accuracy is obtained by the charts constructed for all these phenomena, the reply will be, unfortunately, that they can only be considered as the first sketches of the system of climatological cartography at which meteorology is aiming. If we pass to other meteorological elements, such as humidity, evaporation, amount of cloud, &c., there is no chart existing which embraces an extensive area. These circumstances should not be attributed to the disparity of attention paid to the observations in different countries, for they seem to me rather to depend much more on the difficulty of grouping materials in all respects suitable for investigations of such large dimensions, and on the uncertainty which is still inherent in every combination of observations made in different countries; but I think they are chiefly caused by the large gaps which still exist in the principal systems of observation, in consequence of which the course of the curves over vast regions, both of land and sea, has become

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sufficiently problematical. If *savans* like Dove and Buchan have not shrunk from the unheard—of labour of representing cartographically the monthly temperature, pressure, and wind direction for the entire surface of the globe, if they have well-earned claims on the gratitude of meteorologists, it is nevertheless impossible to deny that owing to the above-mentioned difficulties, their charts cannot give that complete knowledge of the climate of the entire earth which is absolutely necessary for the solution of all the fundamental questions of the science.

If we study the question of the diurnal variations of the meteorological elements, a question which has occupied meteorologists at least from the beginning of this century, we shall find that, in so far as certain localities are concerned, the laws of these variations are pretty well known, thanks to the arduous labours of many meteorologists. But as soon as we wish to find the difference between these variations at different latitudes, their dependence on the continental or maritime situation of the locality, their modifications, with height above sea, &c., our knowledge is limited to the most general qualitative differences; it is all but impossible to give the numerical relations with sufficient exactness to be generally adopted. We then find again here the same great gaps which must be filled up before general laws for the phenomena in question can be established. Our ignorance, respecting the extent to which several of the diurnal variations are applicable, has often led to a proceeding which is generally acknowledged to be incorrect, but which, it seems to me, is much more frequent in this branch of meteorology than in others, namely, that of deducing from the observations made at a single point the meteorological conditions of other, very distant, places. The urgency for the most searching comparisons between the variations at numerous localities, is moreover proved by the fact that diametrically opposite opinions as to the causes of the greater part of these variations, have been enunciated by the most eminent meteorologists of our age.

If we pass to the branch of meteorology which, in recent years, has constituted the principal object of meteorologists, viz., that which treats of the "Non-Periodical Variations," as they were formerly called, or the "General Movements of the Atmosphere," as they are now termed, it appears to me that the difficulties again begin to be felt, as soon as it is a question of grouping together the observations of different countries. In order not to confound the two objects towards which all arrangements tend in this branch of the science, viz., the theoretical and the practical, I shall examine each separately, commencing with the latter.

We may assume it as an axiom that if, at intervals of sufficiently short duration, accurate information as to the state of the atmosphere over a vast area is communicated to a certain place at its centre, this intelligence may usefully serve for determining the modifications which the meteorological conditions will undergo at this same place, or in its vicinity, during that day or the next; and similarly, if the telegraphic arrangements allow of the communication of telegrams on the state of the atmosphere between the central station and the other points of the country, the latter may derive great practical advantage, always provided that the telegrams received at the central station are submitted to a serious discussion, and the telegrams issued by it are modified according to the situation and climatological conditions of the localities to which they are sent. Although all the obstacles connected with the certainty of telegraphic transmission have not been hitherto completely overcome, although more frequent telegrams are probably necessary, and as yet some uncertainty exists as to the best means of utilizing the reports dispatched from the foreign and home stations to the central office, we may, however, I venture to think, admit with sufficient certainty that in every country, which has a central institute of this kind, the difficulties referred to will soon be removed, as they may be attributed almost exclusively to the novelty of the system. The fact that this work may be executed with very great precision is proved, among others, by the remarkable synoptic charts published three times daily by the American establishment under the direction of General Myer. On the other hand, it appears to me infinitely more difficult to attain the requisite certainty as soon as the telegrams of different countries are combined. The most comprehensive work of this kind is that which is carried on daily at the Paris

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Observatory, and which is undoubtedly based upon the grandest idea. But I cannot refrain from expressing the opinion that the practical object in view appears to me to require more accurate data, speedier telegraphic communication, with fewer interruptions, and more numerous stations in several parts of the area covered by the system of observation, &c.; in fine, that the Bulletin of the Observatory cannot yet be considered to have attained the complete perfection of which it is assuredly capable. The Observatory of Paris, which doubtless endeavours by every possible means to smooth away the difficulties caused by the above-mentioned disadvantages, itself acknowledges the want of improved and more complete charts, as it is easy for errors to creep into the original charts. These improved charts have, without doubt, great importance for the pursuit of theoretical researches, but they can in nowise dispel the inconveniences which may arise in the civil life of the different countries, from the fact that the establishment, which has undertaken to furnish each day a general view of the state of the atmosphere over the entire surface of Europe, has not at its command sufficient and perfectly accurate materials. When we know the pains which the Observatory of Paris has taken in the organization and maintenance of this international work, we are led, it seems to me, to the very natural conclusion that no central meteorological station, of any country whatever, can, when left to itself and its own resources, execute in an entirely satisfactory manner a work which requires the co-operation of every country of Europe.

If we now approach the domain of scientific investigation properly so called, and if we examine the resources at the disposal of the meteorologist who wishes to undertake a work on the "General Movements of the Atmosphere," it is incontestable that they have wonderfully increased during recent years, by the quantity of journals which have begun to be published in all countries and observatories, whilst the facility for obtaining them in time for use has also increased in a high degree by the rapidity with which they appear and are distributed.

The discussion of facts relative to meteorology over a large area, the whole of Europe, has met with the greatest assistance in the continuous abstracts on the meteorological conditions of Europe, published by M. Buys Ballot in his "Jaarboek." The collection of the materials required for researches of this kind is no longer accompanied by great difficulties, even if the discussion refers to a period so recent that the observations of all countries are not yet published, for even in this case it is easy to procure the necessary observations, thanks to the readiness with which they are communicated by the directors of central institutions and observatories of the different countries. Nevertheless we find that great difficulties stand in the way of the employment of observations gathered from all parts. Whichever method is used for rendering the observations intercomparable, either their reduction to sea level, or the calculation of deviations from normal values, there is always uncertainty, in the first case, about the height above sea of numerous stations, and, in the second, as to the real magnitude of the normal values. The latter are, as we know, much better determined for certain points than for others, but are entirely wanting for whole countries. Moreover, if we only use a part of the stations of a certain country, in an investigation embracing a large part of Europe, how can we be sure that we have selected those where local influences do not play too great a part. This circumstance has remarkable weight in countries where the stations are far removed from each other. Then follows the question of knowing whether the instruments of one country have been compared with those of other countries or not. It is easy enough for each individual country to effect this comparison, and no doubt it has been done wherever there is a central institution. But the comparison of instruments of different countries, which is requisite for scientific work of general grasp, has hitherto been entirely left to private meteorologists who are interested in works of this kind, and therefore must be considered as very far from having been done in a sufficiently general manner. Notwithstanding the great and real merits of M. Buys Ballot's work, a work which evinces the most strenuous efforts to render the observations of different countries intercomparable, I cannot help thinking that it would become of much greater importance if the stations included in it were most carefully chosen by the meteorologists of the

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countries where they are situated, if their height above sea and their normal values were rigorously determined, if the instruments employed were compared with each other in as direct a manner as possible, if the wind observations were considerably increased, if only such values were entered as were perfectly warranted by the central institutions of the different countries, and lastly, if the network of observation were extended to Asia. If these conditions were fulfilled, the work in question, without any essential alteration of its plan, would certainly be almost exclusively used in every investigation of the general questions relating to the modifications to which the state of the atmosphere in Europe is daily subject.

I think I may conclude, from the preceding remarks, that the fact that the general results have not yet reached the necessary degree of accuracy, and that the number of comparative works of greater generality has hitherto, relatively speaking, been very limited, is mainly attributable to the difficulty of combining with certainty the observations of different countries, as well as to the want of suitably equipped stations over several regions of great extent. In reflecting on the best means of overcoming these difficulties, I am the more convinced that, except in some quite special cases, it cannot be done by the efforts of isolated meteorologists; but that which can only be effected partially, and in an incomplete manner, by individual *savans*, ought to be realized *by the united efforts of all meteorologists*.

The diametrically opposite theories, at present obtaining in several branches of meteorological science, and which may be attributed, at least in part, to the uncertainty still existing in our knowledge of meteorological phenomena, can no longer hold, it seems to me, if we can do away with the difficulties to which I have cursorily referred above. The best proof of the correctness of a meteorological theory is certainly its agreement with observations taken over the entire globe. It is in setting out from this point of view that I attach very special importance to the liberation of general phenomena from their present uncertainty. But as this unfortunate state of things can only be removed, it seems to me, by the united efforts of a great number of *savans*, I venture to call the attention of the Conference to this important circumstance, so that it may become an object of consideration at the Congress of Vienna next year.

Accordingly I take the liberty of proposing the following four questions for discussion at the Vienna Congress:—

1°. What measures should be taken for obtaining, in the shortest possible time, general charts of meteorological elements for which none exist at present, and for improving and completing those already constructed?

2°. How can our imperfect acquaintance respecting the diurnal variation of the meteorological elements at different latitudes, heights above, and distances from, the sea, be remedied in the shortest possible space of time?

3°. How can international meteorological telegraphy be rendered perfectly certain and serviceable in all the countries of Europe?

4°. Is it not desirable that M. Buys Ballot's excellent tables on the state of the atmosphere over Europe should be completed and extended to such a degree as to allow of their being used as a basis for all investigations of the "Non-Periodical Variations" over the whole of Europe, by means of special preparatory works of the meteorologists of other countries?

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XIII.

Mr. G. J. Symons' Notes on some of the questions suggested in the invitation.

(The numbers refer to the questions.)

London, July 27, 1872.

(1.) I do not think identity of scale necessary, but I think that improved and extended conversion tables are so. I do not know of any better than Guyot's, and for the conversion of rainfall measurements they might be rendered more convenient than they are at present. — Uniformity of scales, p. 11.

(2.) The form known as "Kew pattern;" I have a very high opinion of aneroid barometers, but only when they can be frequently compared with a mercurial barometer. — Barometers, p. 13.

(3.) Under the partial direction and at the expense of the Royal Society of London I have for several years been at work upon this subject, and the discussion of the whole of the observations (about 120,000 readings) is nearly completed, and will, I hope, be printed in a few months. I annex (Appendix I.*) description of the experiments, and have only to add that should it appear desirable to try any other plans I would use my best efforts to see them carried out. — Exposure of thermometers, p. 14.

(5.) I think that small-bulb mercurial thermometers with the bulb and one inch of the tube coated with dull black, the whole enclosed in a glass jacket thoroughly exhausted of air, and then mounted on a post so that the bulbs are freely exposed to the sun, and 4 feet above the ground, are the most strictly comparable instruments with which I am acquainted. — Radiation, p. 19.

(7.) I do not consider the dry and wet bulb perfect, but preferable to Saussure's hygrometer. — Hygrometry, p. 34.

(11.) I annex (Appendix II.) copy of rules generally adopted by British observers of rainfall. I think that the funnels should be circular and have strong rims; square funnels, and those not made strongly are more liable to distortion and to warp with the sun's heat With respect to the size of the orifice, very elaborate experiments have been made under my direction, and the result is to show that the variation from this cause is not more than one or two per cent. In actual practice I recommend gauges, whose orifice is 5 inches in diameter, for ordinary stations where observations are made daily, and 8-inch gauges for stations upon mountains and localities only visited monthly. We find in this country that 9 a.m. is by far the most usual and convenient (and therefore punctually adhered to) time of observation. — Rain gauges, p. 39.

(12.) Yes, I think it is desirable. — Separation of rain from snow, p. 40.

(13.) I think not. — Of "Graupel" from hail, p. 40.

(14.) I should reckon the number of "days of storm," but heat-lightning being really a distant storm would hardly seem entitled to be included. — Thunderstorms, p. 41.

(15.) Very elaborate and costly experiments on this subject are in progress at the expense of the Royal Society of London, under the superintendence of Mr. Rogers Field and myself; some information on the subject is given in Appendix III. — Evaporation, p. 41.

(16.) By all means introduce such symbols if possible. — Proportion of cloud, p. 41.

(20.) I think on the whole the 1st of January is to be preferred. — Calculation of means, p. 25.

I venture to suggest that an international exhibition of meteorological instruments would be a useful feature of the Congress of 1873, but it must be far more complete than at any of the previous exhibitions if it is to be of service to meteorology.

62, Camden Square, London.

* Mr. Symons has forwarded with his letter two pamphlets (Appendix I. and III.), of which the first contains the various forms of thermometer-stands, the second those of vaporimeters, and also a sheet (Appendix II.) with rules for the observers in respect of the measurement of rain. These Appendices contain numerous woodcuts, which have already been printed elsewhere, (in the "Monthly Meteorological Magazine," and the "Reports of the British Association,") and cannot be reprinted here.

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XIV.

Prof. Dr. R. Wolf, Director of the Observatory in Zürich, to Director Beuhns.

Zürich, August 1st, 1872.

In addition to other reasons, the determination of longitude between Gäbris, Zürich, and Pfändler, which is at present in progress, prevents my going to Leipzig to take part in the Meteorological Conference. Accordingly I allow myself to hand in my vote by this letter, which I request you to communicate in my name. In it I shall hold to the numbers of the programme and remark :—

Uniformity of scales, p. 11.

1. As units of measurement, millimetres and Centigrade degrees should be unconditionally maintained, and especially Reaumur and Fahrenheit degrees should be set aside wherever it is possible.

Hygrometry, p. 34.

7. The psychrometer always gives wrong results when frost and thaw alternate quickly, but not so the hair hygrometer. It is therefore requisite, at least at central stations, to let each instrument check the other.

Direction of wind, pp. 36, 37.

8. Lambert's formula is valueless.

Uniform times of observation, p. 20.

18. It is scarcely possible to introduce uniform periods of observation. If, *e.g.*, in Switzerland, our hours 7, 1, 9, were to be changed for 6, 2, 10, probably more than half of our observers, and at all events the majority of our mountain stations, would drop off.

Calculation of means, p. 25.

20. The meteorological year certainly begins more suitably with December than with January; I could only give my vote for January (*sic*).

Uniformity of publications, p. 29.

22. The style of publication must be left to the individual countries, as it depends on the special circumstances of the countries. *At most* the Meteorological Conference can name a minimum which is desirable, *e.g.*, wish, that not only means, but also at least two of the actual daily observations should be published for a number of stations in each country.

Plans for Congress, p. 34.

26. However desirable it may be that meteorologists should come to a mutual understanding as to what is *wished*, an object which, in my opinion, will be better attained by written than by verbal communications, they must guard against letting themselves be *ordered*. In order to carry out the views, *example* and *precept* are the best and the only practicable means.

APPENDIX B.

Proceedings of the Meteorological Section of the French Association for the Advancement of Science, held at Bordeaux, September 1872.

The *French Association for the Advancement of Science* held its first meeting at Bordeaux from Thursday, 5th September, to the following Thursday. It inaugurated the vast building erected for the Philomathical Society for the Instruction of Adults.

The hospitality of the town was worthy of this intelligent city, and a great number of the inhabitants took an active part in the labours of the association.

The Association, besides the general sittings, divided itself into four groups comprising 15 Sections. We have only to notice here the work of the Section of Meteorology and Terrestrial Physics. The programme had been previously drawn out, in conformity with the series of questions put by MM. Bruhns, Wild, and Jelinek, in the invitation to the Meteorological Conference at Leipzig. Other questions of special interest to France were added to them. We shall resume, question by question, the results of the deliberations, while

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specially thanking MM. Linder, Raulin, and Belime for the devoted assistance they have rendered in this examination.*

1. Uniformity of measures is highly desirable; but even supposing it accepted in principle by every country, its complete realization would require a considerable length of time. It appears, therefore, immediately necessary to take steps for reducing the different measures to the same standard, and to make this reduction in the publications of an international character. Uniformity of scales, p. 11.

It is not equally necessary to introduce currently into the general science all the observations of any one country, which are issued in the local publications. The science must first rest upon a limited number of well-chosen and suitably equipped stations. It is of consequence that the observations made at these stations should be placed at the disposal of all meteorologists without delay, and in such a state of preparation as will render their use easy. The details of the science for some time yet may be left in each country to the exclusive care of its own meteorologists. During this time the incontestable advantages to be derived from the complete uniformity of measures will be more and more apparent, and the transformation will be effected without too much effort.

2. At all land stations it is desirable that none but mercurial barometers should be made use of; but Fortin's barometer may be simplified for stations of the second order, so as to reduce its price. There are barometers with a moveable cistern, graduated on glass, at the price of 35 to 40 francs. There are barometers requiring only one reading, graduated on glass or copper. M. Baudin has announced one, said to be very accurate and at an equally moderate price, but we have not yet received it from him. Our type barometer is still that of Fortin; not that its principle is the only one which may be accepted, and free scope must be allowed to the efforts of the makers. But it appears essential to us that each country should have at least one central establishment provided with a normal barometer which has been rigorously compared with those of other similar establishments, and the central observatory of each district should undertake the examination and verification of the mercurial barometers made in, or for, that district. Barometers, p. 13.

The section of meteorology expresses the wish that in France the Inspector General of Meteorological Stations will verify on the spot all mercurial barometers at the French stations and make their corrections known.

As to metallic barometers, they present serious defects, their zero is displaced in time and often in an accidental manner, and furthermore their temperature correction is uncertain. They should only be used therefore as weather glasses. From this point of view their use cannot be too much recommended or spread.

3. This is one of the most delicate questions in meteorology. The exposure of thermometers varies very much from one station to another, and each exposure gives different results. Let us add, however, that the differences affect the extreme temperatures much more than the means. Exposure of thermometers, p. 14.

In France the thermometers are generally sheltered by a double roof, sloping towards the south, and about a square metre in size. They are removed from buildings, and the ground, from which they are about two metres distant, is covered with grass. Abroad, they are often enclosed in screens made of venetian or louvre work. Then the radiation of the screen itself takes the place of that of the sky or ground.

In the present state of things it seems to us difficult to require the meteorologists of different countries to adopt immediately a uniform plan with regard to thermometers. We must first illustrate the advantages and disadvantages of each method by means of experiments made simultaneously on different plans. This task is incumbent on the national observatories, and if the investigation is commenced at once, meteorologists, if they bring their results with them to the Vienna Congress, may take up the question with the hope of solving it. But we must not simply confine ourselves to the future. We must think of the past, and of the long series of observations it has handed down to us. With this view it is necessary to determine exactly the correction due to each mode of exposing the thermometers.

* The proceedings of the Meteorological Section of the meeting at Bordeaux are so closely related to those of the Meteorological Conference at Leipsig that it seems allowable to introduce them here, although this publication, as will be seen from its form, was not addressed to the latter Conference.

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Maximum and minimum thermometers, p. 17.

4. Rutherford's Minimum thermometers, with uncoloured spirit, graduated on the stem, and compared in the shade with a good mercurial thermometer, are good instruments and will work a long time.

The Maximum thermometer called Walferdin's is almost irreproachable when in use; but it has the disadvantage of being easily deranged during transit from one place to another. It is true that it can be very easily set right, but this operation, however simple it may be, requires a certain amount of practice, and must be done in the presence of an expert. Consequently Negretti and Zambra's maximum thermometers are often preferred to Walferdin's; they have no thermometric chamber, and so the mercury never leaves the bulb during transit. On the other hand the thermometer often "pumps," that is to say, its column jerks from one to two tenths of a millimetre; and the verification of its zero is very uncertain in the hands of anyone who is not used to it. At the Paris Observatory we employ only Walferdin's Maximum thermometer, in conjunction with Six's self-registering thermometer, which, notwithstanding its defects, is maintained for its antiquity. In the provincial observatories Negretti's thermometer is always used whenever it has to be forwarded by ordinary means, but the tendency is to replace it by Walferdin's.

Radiation, p. 19.

5. We only know of one instrument capable of accurately measuring the intensity of diurnal and nocturnal radiation—that is Melloni's pile, performing with a single-needle galvanometer, and whose graduation is obtained by arranging in front of its two faces surfaces coated with lamp-black and of known temperatures. One of these surfaces always remains in its place, while the free face of the pile receives the direct action of the radiations it is wished to measure. But this is a laboratory apparatus, whose use is limited to a few observers; it is not an instrument for ordinary observation.

Pouillet's pyrheliometer can only be used for measuring the direct solar radiation; the same may be said of the Rev. Father Secchi's actinometer, which only shows the rays transmitted through glass, if its case is closed in front by a pane of glass, or, in the contrary case, is influenced by the agitation of the air.

The black-bulb thermometer, placed in an exhausted glass tube, has the advantage of being as easily read as the ordinary thermometer, and giving the radiation arising from the whole of the sky. It must have *a complete view* of the sky; every portion that is masked from it produces a diminution of the total result. It appears to us necessary also to place an ordinary thermometer, also *in vacuo*, by the side of the black-bulb thermometer. The size of these instruments has a slight influence on their readings. They should therefore be first compared with a standard, or, better still, with the indications of the thermo-electric pile, in order to determine their correction.

Thermometers in a vacuum cannot be used for measuring nocturnal radiation; obscure heat does not pass easily through glass, it is the envelope alone that radiates, and we fall into the disadvantages presented by thermometers without an envelope; the movement of the air modifies their indications. The thermo-electric pile, giving almost instantaneous readings, is alone efficient; we think that this alone can be used as a starting point and a normal instrument for correcting ordinary observing instruments, and for determining the trustworthiness of their indications. This is an investigation which is yet to be made.

Earth temperatures, p. 19.

6. The question is twofold:—

From the general point of view of the Physics of the globe, we must descend to as great a depth as the funds permit, to 30 and 50 metres and more, if possible, according to the nature of the soil. M. Becquerel's electrical thermometer seems to us to be the only one applicable to this case. It would be desirable that sets of this apparatus should be established in each of the principal geological regions, from the north to the south of Europe.

From the point of view of meteorology properly so called, a thermometer placed on the surface of the ground would suffice, and others placed at depths reached by the ploughshare or by the roots of plants. At the depth of a metre thermometers with stems rising above the ground, and capable of being read directly, already require difficult corrections, unless provided with a second

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stem without a reservoir, and graduated like a thermometer. Again, the temperature of the surface of the soil differs greatly according to its nature, and the indications of this kind are as special as those of climate; the observations should therefore be multiplied.

7. The psychrometer is a good instrument, if not absolutely good, in the hot season, or in hot countries. But during the cold of winter it wants sensitiveness, and becomes inferior to the most ordinary hair hygrometer. Hygrometry, p. 34.

The hair hygrometer, as it is now made, is not a trustworthy instrument; the hair is stretched by too great a weight, especially when the weather is becoming dry again, and consequently it deteriorates rapidly. Arago has remedied this defect by employing three hairs attached to the same pulley at their lower end, and fixed at their upper extremity to the ends of small levers which allowed a compensation for their unequal extension. This very simple expedient allowed of the use of an instrument, which cannot in all cases be replaced by the psychrometer.

On this point, as on all others, it would be necessary that, in each country, the instruments employed should be submitted to a regular test, so as to preserve the comparability of their indications. The best means for checking hygrometry is always chemical analysis, in laboratories suitably furnished, or else Regnault's condensing hygrometer, in which the silver cup may be replaced by a small tube of bluish-black glass.

8. Sixteen points would seem to us sufficiently definite for indicating the direction of the winds. As to their velocity, it is to be hoped that the use of anemometers will be generally adopted. Robinson's anemometers, furnished with a simple kilometric meter, formed by a series of toothed wheels, and read at the hours of ordinary observation, are moderate in price and give the mean velocity of the wind, in the interval between the observations, with sufficient approximation. If they are erected in a very open place it is not necessary to fix them at a great height, but at the principal observatories it would be well to set up several of these instruments at different heights, in order better to determine the variation of the velocities, from the surface of the ground, to the most elevated accessible regions of the atmosphere. An erroneous interpretation of the law of propagation of velocities, from one stratum to another, has given rise in France to lamentable accidents. Two of these instruments are erected, or are ready to be erected, at Montsouris. One has been placed by M. Deville at the top of a mast 29 metres high; a second will be placed at 3 metres only above the ground, at a distance sufficiently removed from every obstacle to the progressive movement of the air. Direction of wind, pp. 36, 37.

We prefer wind roses, with the velocities introduced, to the mean direction of the wind calculated by Lambert's formula, but we should not make any objection to introducing both methods if meteorologists expressed a wish for them. In cases where the velocity is recorded by an anemometer, it seems to us that the wind denoted by zero should not be counted. Very gentle breezes are generally quite local, and show rather the vertical movements, which are important subjects of study, than the movements of horizontal translation.

9. From a telegraphic point of view, it is desirable that the scale adopted should only consist of a single figure for each degree of force, that it should go, for example, from 0 to 9 as a maximum; this scale is adopted by the French navy. For the construction of charts it is rather less comprehensive; we limit ourselves to the scale 0—6, which is half the English scale. But there would be no serious objection to the adoption of any scale which should unite the majority of votes. Scale of wind force, p. 38.

10. We think that the anemometers mentioned in No. 8 would be of great use, and if the same unit cannot be at once employed in all countries, we would only ask that uniformity should be introduced into all publications of an international character, the arrangement of which by the Congress seems to us to be most desirable. We shall revert to this in No. 22. Velocity of wind, p. 39.

11. The simplest rain gauge, and that most used in France, is the one recommended by the Scientific Association, whose circular funnel has a surface of 4 sq. decim. At the observatory the vessel for receiving the water is placed in a pot sunk in the ground, so that the rim of the funnel is nearly at the mean height of the grass, 10 or 12 cm. above the bare ground, and in a very open Rain gauges, p. 39.

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space. At the normal schools, and similar stations, Babinet's udometer is employed, enclosed in a wooden box, the top of which is formed by the funnel, so that, by placing a lamp inside in winter, the snow adheres to the funnel and melts as it is received. The height of the top of the instrument above the ground is in this case about 2 metres.

At the observatory the rain gauge is read at all the hours of observation, but, in the monthly summaries, all the rain which has fallen until 7 or 8 a.m. is added to that of the day before.

Separation of rain, snow, &c., p. 40.

12 and 13. We think so. They are so many distinct signs of the condition of the atmosphere, and are easily noted by means of conventions independent of difference of language.

Thunderstorms, p. 41.

14. With regard to the first point, we think both should be done; as to the second, the regular observation of thunderstorms in France has shown that thunder is not heard above 5 or 6 leagues, while lightning may be perceived at a distance of more than 30 leagues, The so-called heat-lightning is generally a sign of distant thunderstorms; on this account it should be noted, specifying the direction of the horizon in which it appears.

Evaporation, p. 41.

15. Piche's vaporimeter appears to give the most comparable results. The colour of the paper, whether white, blue, red, or green, has a very marked influence on the results when exposed to the sun. In the shade, the differences decrease greatly, and when white paper is used the results are almost identical, either in the sun or shade. We think it best to place the vaporimeter, furnished with a disc of white paper, under a little screen which shelters it from sun and rain. That is our normal vaporimeter, but the observatory would be inclined to establish vaporimeters conformably to those adopted in other observatories, and as far as possible in identical conditions, so as to compare their indications. This step might usefully be made with respect to all meteorological instruments, and be adopted in the principal observatories, at least temporarily.

Proportion of cloud, p. 41.

16. The employment of tenths of clear, or cloudy, sky would require the use of two figures, which for telegraphic reports would be a disadvantage. The symbols engraved by the Meteorological Society for its "Nouvelles" only go from 0 to 4. Before engraving the symbols for the "Bulletin mensuel" of the Montsouris observatory, we shall wait until meteorologists have made known their ideas on the matter. The same may be said of the other symbols proposed to represent the various meteorological elements.

Extra observations, p. 42.

17. We think it useful to extend the field of regular observations as much as the resources of the various meteorological establishments allow. Ozone and atmospheric electricity should be included, but up to the present time atmospheric electricity has not been taken up at Montsouris, as the official and definitive constitution of that observatory dates only a few months back. Although this element enters into our programme, we are unable at present to give any fixed opinion about it.

Could not the Congress also give its attention to observations of Sea Temperature, and the direction and velocity of Marine Currents? These observations are regularly made on several points of the coast of Europe, and especially of France, but they are generally ignored, because they are not yet regularly introduced into the usual meteorological publications.

Uniform times of observation, p. 20.

18. This would be very desirable, but if this result cannot be obtained, there should be at least a certain number of similar hours, in each of the series adopted by the various establishments, to serve as stand points.

Inspections and verifications, p. 23.

19. We think so, and we believe it would be one of the greatest advantages which can possibly be realized in meteorology.

Calculation of means, p. 25.

20. The most convenient periods for us are the day, month, season, and the year, but especially the day, which forms the basis of all discussions. The distribution of temperature and rain, for instance, in the succession of days of a year exerts a decisive influence on the crops, and this action is difficult to recognise in periods, however short they may be.

We think it necessary to publish the daily means every month, and then the commencement of the year is only of secondary importance. The meteorologist will group his observations in the manner most conformable to the object

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of the study which he has undertaken; the essential point is that these comparable elements should not be wanting.

The calculation of means varies according to the districts. The chief observatories have at their disposal multitudinous observations made at different hours of the day, and possess a more or less numerous staff, which is not found at stations of the second order. Maximum and minimum thermometers greatly simplify the work; it would therefore seem useful to employ them more generally.

Calculation of normal values, p. 28.

21. The series of observations made at observatories or meteorological stations are of very unequal duration, and embrace very different periods. It does not appear to us prudent to compare them together in bulk, and without discussion; this would be running the risk of grouping, for two different stations, years very unlike in character, and so falsifying the climatal relations of these two stations.

There is scarcely a country in Europe where at least one regular and trustworthy series, dating back almost to the time when meteorological observations were begun, cannot be found. These series might usefully serve as a starting point for the discussion of all the rest. Being given a station belonging to a district for which there exists a normal series, we should think it desirable to compare the means of this station, not with the whole of the normal series, but with the number of years of this series which correspond to the observations at the station in question. The two specimen diagram sheets published in the "Bulletin mensuel de Montsouris" for the year 1865–7 have been constructed in accordance with this idea.

For Paris the unbroken curve represents the mean monthly temperatures observed during these years; the dotted curve shows the march of the normal mean temperatures deduced from 60 years' observations at Paris. For all the other stations also the unbroken curve represents the monthly means observed at their dates, but the dotted curve exhibits, not the normal mean temperatures for Paris, but the monthly means for Paris obtained for the same time as those for the stations.

In this comparison we must not embrace points which are too far asunder, or too close to each other, but comprised in dissimilar climates; the work must be guided by an attentive discrimination; but the introduction of years into the comparison which exist in one of the terms, but are not found in the other, would appear to us at least as fallacious.

Uniformity of publications, p. 29.

22. This would certainly be most desirable and most profitable to science. Not only should the documents be inserted in a definite order, but the form itself should be determined by common consent. In forming a meteorological library, nothing is so troublesome and disagreeable as the extreme variety of the dimensions adopted in the publications of different countries. The changes experienced by the Paris Observatory during several years, and from which it had apparently just escaped when the death of M. Delaunay occurred, have produced modifications in the form of its publications, the general tendency of which has been to bring them to one size, Royal quarto. But whatever be the decision arrived at by the Congress of Vienna, we are quite disposed to conform to it.

We accept completely the terms of the above-stated question, but at the same time we should like to go beyond it, in taking up the question of publications having an international character. We should like to see the care of these publications divided among the various establishments of the first order.

We may be permitted here to cite some of the opinions examined by the Congress at Bordeaux, without wishing in any way to anticipate the decisions of the Vienna Congress, and more especially without transgressing the personal courtesy due to the honourable *savans* whose names we quote.

The following is the last paragraph of M. Rubenson's printed letter:—

"Is it not desirable that M. Buys Ballot's excellent tables on the state of the atmosphere over Europe should be completed and extended to such a degree as to allow of their being used as a basis for all investigations of the "Non-Periodical Variations" over the whole of Europe, by means of special preparatory works of the meteorologists of other countries?"

We share this wish, and for our part would adhere to it, adding that it would

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be equally desirable that this same establishment, or others, were charged with the extension of the network to Asia, America, and the Oceans too.

Another question of a similar kind has been raised by M. Rubenson :—

"What measures should be taken for obtaining, in the shortest possible time, general charts of meteorological elements for which none exist at present, and for improving and completing those already constructed?"

The Observatory of Paris had undertaken an Atlas of the General Movements of the Atmosphere over the surface of the Atlantic and of Europe. Circumstances which need not be recalled here have interrupted this work, which has been partially resumed by M. Mohn. Instead of leaving to this useful work the somewhat personal character which it has maintained up to the present time, notwithstanding the co-operation of different meteorologists, it cannot be doubted that its adoption by a higher authority would ensure its duration, while furnishing it with more powerful means of action. Without in any way trammelling the free development of individual efforts, it seems to us that if meteorologists could agree as to the grand works that the science demands, and as to their division among the establishments disposed to undertake them on the general basis decided by the Congress, the science would advance with rapid strides. Each work effected would, moreover, open out new fields, and the congresses becoming periodical, the general work could each year be made to conform to the new conditions arising from the progress made.

Exchange of publications, p. 31.

23. We shall content ourselves by stating here what is done in France. The Observatory is allowed to send the "Bulletin International" post free over French territory, but this privilege ceases at the frontier. The numerous meteorological documents which are sent from France to the Observatory are enclosed in an envelope addressed to the Minister of Public Instruction, and bearing the words "Service Météorologique;" these documents are sent free to the Observatory. The transmissions from the Observatory to its correspondents in France are sent free in the same way, provided the address is not Mr. So and So, Prefect, Director, or President; but simply "The" Prefect, Director, or President. If the "frank" stops at the frontiers, it is because it is not recognized by the other states; but free transmission being given for meteorological despatches by telegraph, the same might also be conceded, as regards the post, under certain conditions, which may be easily imagined and carried out. There is the consular route also, of which we occasionally make use.

Establishment of central offices, p. 31.

24. Such an establishment exists in France, and it enters into the traditions of the country there, but it only wishes to possess a moral influence over its correspondents; it limits itself to furthering their works and to contributing to give them greater homogeneity and to make them known. The bonds which link the stations to the central establishment are quite voluntary, and that is sufficient.

Weather telegraphy, p. 32.

25. We shall content ourselves with reproducing here M. Fradesso da Silveira's reply to this question in his printed letter:—

"It appears to us that the exchange of meteorological telegrams becomes indispensable; but this interchange will not produce the results which might be expected, until all countries take suitable steps for preventing delay in the transmission of bulletins."

An inspection of the Daily Bulletin of the Observatory shows how far this condition is from being realised.

Plans for Congress, p. 34.

26. The Congress of Vienna may take place by the voluntary meeting of meteorologists of different countries. They will have sufficient standing to discuss the questions relative to the future of their science, and to enter into personal engagements to carry out the conditions prescribed. The solutions proposed by this assembly, even if it were merely of a private nature, entirely without any official connexion, would no doubt have great authority with the respective governments; we think, however, that under these conditions the meeting would lose much of its efficacy.

In the majority of European states, meteorological institutes or establishments are founded and maintained by the governments; and whatever authority they have in their own country, the directors of these establishments are responsible, both for the works which are entrusted to them, and for the resources, in materials and staff, placed at their disposal.

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The deliberations of the Congress may, and ought to, bring about modifications in the nature and conduct of the works undertaken; financial and other engagements may, and should, result from them, either by the proposal of new units of measure, the origination of publications of general utility, or the request for free transmission, by telegraph or post, on a more extensive scale. If questions of such a nature may be raised it seems that the Governments interested ought at least to be invited to represent themselves officially. They alone, in fact, can give to the Congress a really International character, and are able to give a guarantee that the necessary steps shall be taken to give effect to its deliberations.

It seems therefore necessary that the organizers of the Congress should obtain the official adherence of the Governments to the projected meeting.

That if these steps are thought unnecessary or inopportune, the first Congress, while maintaining a private character, should endeavour to establish an International Association of acknowledged public utility, having regular sittings like the International Geodetical Society, and like it appointing a permanent working committee, whose duty should be to prepare for future meetings, and to watch over the execution of former resolutions. Whatever amount of activity may be displayed by the meteorologists assembled at Vienna they can only sketch out the preliminary groundwork of their future operations. The organization of a science, requiring such great co-operation and uniformity of method, cannot be the work of a day; it requires permanent and prolonged exertion.

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For Her Majesty's Stationery Office.
[9088.—750.—2/73.]
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LIST OF PUBLICATIONS, &c. issued under the Authority of the Meteorological Committee.

OFFICIAL.

No. 1. Report for 1867. Presented to Parliament. Price 1s.

2. Instructions for Meteorological Telegraphy. Price 6d.

3. Fishery Barometer Manual. Price 6d.

4. Charts of Surface Temperature, South Atlantic Ocean. Price 2s. 6d.

5. Report for 1868. Presented to Parliament. Price 6d.

6. Report for 1869. Presented to Parliament. Price 10d.

7. Quarterly Weather Report for 1869.—Parts I. to IV. Price 6s. each. [Published by Stanford, Charing Cross.]

8. Barometer Manual. Price 1s.

9. Quarterly Weather Report for 1870.—Parts I. to IV. Price 6s. each. [Stanford.]

10. Report for 1870. Presented to Parliament. Price 10d.

11. Contributions to our Knowledge of the Meteorology of Cape Horn and the West Coast of South America. Price 2s. 6d. [Stanford.]

12. Currents and Surface Temperature of the North Atlantic Ocean, from the Equator to Latitude 40° N., for each Month of the Year. With a General Current Chart. Price 2s. 6d. [Stanford.]

13. A Discussion of the Meteorology of the Part of the Atlantic lying North of 50° N. for the Eleven days ending 9th February 1870. Price, with Book of Charts, &c. [Stanford.]

14. Quarterly Weather Report for 1871.—Part I. January–March. Part II. April–June. Price 6s. each. [Stanford.]

15. Report for 1871. Presented to Parliament. Price 10d.

16. Quarterly Weather Report for 1872.—Part I. January–March. Price 6s. [Stanford.]

NON-OFFICIAL.

No. 1. Report to the Committee on the Connexion between Storm Winds and Barometrical Differences.—By Robert H. Scott, Director of the Office. Price 6d.

2. Report to the Committee on the Meteorology of the South Atlantic.—By Captain H. Toynbee, Marine Superintendent. Price 1s.

3. Report to the Committee on the Use of Isobaric Curves.—By Captain H. Toynbee, Marine Superintendent. Price 1s.

4. Routes for Steamers from Aden to the Straits of Sunda and Back. Price 6d.

5. On the Winds, &c. of the North Atlantic, along the Tracks of Steamers from the Channel to New York. Price 6d.

6. Report of the Proceedings of the Meteorological Conference at Leipsic. Price 1s.

Sold by Potter, 31, Poultry, and Stanford, Charing Cross.

The Annual Reports may be obtained of all Parliamentary Booksellers.

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Official No. 91.

REPORT

OF

THE PROCEEDINGS

OF THE

METEOROLOGICAL CONGRESS AT VIENNA.

PROTOCOLS AND APPENDICES.

TRANSLATED FROM THE OFFICIAL REPORT.

Published on the Authority of the Meteorological Committee.

LONDON:
PRINTED FOR HER MAJESTY'S STATIONERY OFFICE,
AND SOLD BY
E. STANFORD, CHARING CROSS.

1874.

Price One Shilling.

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Official, No. 21.

REPORT

OF

THE PROCEEDINGS

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METEOROLOGICAL CONGRESS AT VIENNA,

PROTOCOLS AND APPENDICES.

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1874.

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INTRODUCTION.

GENTLEMEN,

I HAVE the honour to submit to you a translation of the Report of the Proceedings of the Meteorological Congress of Vienna in September last.

The text followed differs from that of the German original in that the alterations contained in the table of errata have been introduced, and that a few additional corrections, which have been noted in their proper places, have been inserted.

There is yet a further Report to appear. It is on the subject of Weather Telegraphy and Storm Warnings, and was presented to the Congress by a Committee appointed by the Meteorological Conference at Leipzig in 1872. This Report will be printed separately.

Your obedient Servant,

ROBERT H. SCOTT.

To the Meteorological Committee of
the Royal Society.

Dec. 22, 1873.

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LIST OF THE DELEGATES

TO THE

International Meteorological Congress, Vienna, 1873.

Name.	Designation.	Delegate for
Aguilar, A. -	Director of Madrid Observatory -	Spain.
Buys Ballot, H. -	Director of the Royal Meteorological Institute of the Netherlands, Utrecht.	The Netherlands.
Bruhns, C. - -	Director of the Royal Observatory at Leipzig.	The German Empire.
Buchan, A. -	Secretary of the Scottish Meteorological Society, Edinburgh.	Great Britain and Ireland.
Campbell, J. D. -	Chief Secretary of the Inspectorate-General of Chinese Maritime Customs.	China.
Cantoni, G. -	Professor at the Royal University at Pavia.	Italy.
Coumbary, A. -	Director of the Central Physical Observatory at Constantinople.	Turkey.
v. Czelechowsky -	Ministerial Secretary in the Imperial Royal Ministry of Commerce.	Austria.
Doergens, F. -	Assistant at the Royal Prussian Meteorological Institute.	The German Empire.
Donati, G. B. -	Director of the Royal Observatory at Florence.	Italy.
Ebermayer, E. -	Professor at Aschaffenburg - -	Bavaria.
Fradesso da Silveira	Director of the Observatory at the Polytechnic School at Lisbon.	Portugal.
Gloesener, M. -	Inspector of Telegraphs at Liége.	Belgium.
Hann, J. - -	Adjunct at the Imperial Royal Central Meteorological Institute at Vienna.	Austria.
Hoffmeyer, N. -	Director of the Royal Danish Meteorological Institute at Copenhagen.	Denmark.
Jelinek, C. - -	Director of the Imperial Royal Central Meteorological Institute at Vienna.	Austria.
Lorenz, J. - -	Ministerial-rath in the Imperial Royal Ministry of Agriculture at Vienna.	Austria.
Mohn, H. -	Director of the Royal Norwegian Meteorological Institute at Christiania.	Norway.
Müller, R. - -	Director of the Imperial Royal Hydrographic Office at Pola.	Austria-Hungary.
Myer, A. J. -	Brigadier-General, Chief Signal Officer of the United States Army, Washington, D.C.	United States of North America.
Neumayer, G. -	Hydrographer of the Imperial Admiralty at Berlin.	The German Empire.
Plantamour, E. -	Director of Geneva Observatory -	Switzerland.
Quetelet, E. -	Astronomer at the Royal Observatory at Brussels.	Belgium.

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Name.	Designation.	Delegate for
Rubenson, R. -	Director of the Royal Swedish Meteorological Institute at Stockholm.	Sweden.
Schenzl, G. -	Director of the Royal Hungarian Central Meteorological Institute at Pesth.	Hungary.
Schmidt, J. -	Director of Athens Observatory -	Greece.
Schoder, H. -	Professor at the Polytechnic School at Stuttgart.	The German Empire.
Scott, R. H. -	Director of the Meteorological Office, London.	Great Britain and Ireland.
Sohncke, C. -	Professor at the Polytechnic School at Carlsruhe.	The German Empire.
Wild, H. - -	Director of the Imperial Russian Central Observatory at St. Petersburg.	Russia.
Winnecke, F. -	Director of the Strasburg Observatory.	The German Empire.
Zamara, A. -	Inspector of the Imperial Royal Marine Office at Trieste.	Austria.

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PROCEEDINGS

OF THE

METEOROLOGICAL CONGRESS AT VIENNA.

Protocol of the First General Meeting of the International Meteorological Congress at Vienna.

1st Meeting.

Vienna, September 2, 1873.

Commencement of sitting, 10.30 a.m,

PRESENT:

His Excellency the Minister of Instruction, Carl von Stremayr.

DELEGATES:

MM. Bruhns, Buchan, Buys Ballot, Campbell, Cantoni, Coumbary, Czelechowsky, Donati, Dörgens, Ebermayer, Gloesener, Hann, Hoffmeyer, Jelinek, Lorenz, Mohn, Müller, Neumayer, Plantamour, Quetelet, Rubenson, Schenzl, Schoder, Scott, Sohncke, Wild, Winnecke, Zamara.

Of the visitors invited the following were present:—

As representative of the Minister of War, Rear-Adm. G. v. Millossich.

Dr. W. Köppen, Assistant at the Central Physical Observatory, St. Petersburg.

M. St. Kostlivy, Assistant at the Central Meteorological Institute, Vienna.

Dr. Th. v. Oppolzer, Regierungsrath and Professor in the University of Vienna.

M. F. Osnaghi, Adjunct at the Central Meteorological Institute, Vienna.

Dr. Aug. Petermann, Gotha.

M. E. Sedlaczek, Lieut.-Colonel, Institute for Military Geography, Vienna.

Dr. Edm. Weiss, Professor in the University of Vienna.

M. JELINEK, in the name of the Permanent Committee elected at Leipzig in the previous year, declared the meeting opened.

Thereupon, HIS EXCELLENCY THE MINISTER OF INSTRUCTION, C. v. STREMAYR welcomed the Congress in the name of the Government in the following speech:

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1st Meeting.

It is a fruitful thought to introduce in all countries, by the personal intercourse of and united action between men of science, a common system of observation, and a discussion of the meteorological phenomena which in their varying form are manifested over the entire earth. In this way not only will scientific investigation more speedily reach its goal, but also that highly practical point of view will be sooner attained, which will direct on the progress of meteorology, the eyes, not only of sailors and agriculturists, but of all educated men. My first duty, therefore, is a pleasant one, to express to all the Governments most sincere thanks for the great readiness with which they have supported this undertaking by sending their delegates.

You especially, gentlemen, do I greet most heartily in the name of the Austrian Government, and I accompany the laborious work which will be thrown upon you during the next few days, with the honest wish that the history of the exact sciences will mark the *First International Meteorological Congress in Vienna* as an important turning point in the development and importance of meteorology.

M. Buys Ballot, in the name of the Congress, thanked the Imperial Government, for the successful organization of the Congress, and His Excellency for the kindly words of welcome which had fallen from him. The thanks were expressed by the members by rising from their seats.

M. Jelinek briefly touched on the questions to be discussed by the Congress, and he saw a favourable omen for their satisfactory solution in the circumstance that almost all Governments which had received invitations had sent representatives. There was one serious exception, for one country which had yielded distinguished contributions to the department of exact science, was not represented at the Congress, but even in this case co-operation in the common work might confidently be expected: it was further to be regretted that by the mode of the constitution of the Congress, which only admitted delegates of Governments, it has become impossible for many eminent meteorologists, who had been present at the Leipzig Conference, to take part in the labours of the Meteorological Congress.

Finally he held it for his duty on the day of the opening of the Congress to refer to those men who for a long series of years had held the first rank in the sciences of Meteorology and Terrestial Magnetism, and had introduced into the science a more comprehensive treatment of the various questions from a more general point of view, and, inasmuch as they had insured the general recognition of the necessity of working in common, had rendered possible, and smoothed a way for the meeting of to-day. He would only mention three most eminent names, as the men who bore them were unfortunately absent from the Congress; Geheim. Regierungsrath Dove, of Berlin, who had been prevented, owing to the delicate state of his health, from accepting the office of delegate; Director Adolphe Quetelet, of

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Brussels, the President of the Maritime Conference at that place in 1853; and General Sir Edward Sabine, of London, the founder of Magnetical and Meteorological Observatories over distant points of the earth's surface. 1st Meeting.

The members showed their recognition of the services of the gentlemen named, and their regret at their absence, by rising from their seats.

M. JELINEK then submitted to the Congress some communications which had been received, the majority of which would be considered in detail in the course of the proceedings. Only one of them required special notice at this juncture, viz., the communication from the Imperial Academy of Sciences, placing its meeting-apartments at the entire disposal of the Congress.

The meeting then proceeded to the choice of the Bureau. His EXCELLENCY THE MINISTER OF INSTRUCTION was chosen Honorary President, and accepted the post with thanks.

As Vice-Presidents were nominated :—

MM. Bruhns.	MM. Scott.
Buys Ballot.	Wild.
Jelinek.	

As secretaries :—

MM. Müller.	M. Sohncke.
Neumayer.	

The proposed Byelaws and the Programme of Proceedings which were to be discussed at the next meeting were then read.

The following Agenda were adopted for the next meeting (Wednesday, September 3, 10 o'clock) :—

1. Discussion on Byelaws and Programme.
2. Appointment of Sub-committees.
3. Discussion on Questions 12–17 of the Programme.

Close of the sitting at 11.30 a.m.

Verified at the meeting of September 3 by the Chairman.

BUYS BALLOT.

Protocol of the Second General Meeting, 3rd September 1873. 10.20 a.m. 2nd Meeting.

Present :—MM. Bruhns, Buchan, Buys Ballot, Campbell, Cantoni, Coumbary, Czelechowsky, Donati, Dörgens, Ebermayer, Gloesener, Hann, Hoffmeyer, Jelinek, Mohn, Müller, Neumayer, Plantamour, Quetelet, Rubenson, Schenzl, Schoder, Scott, Sohncke, Wild, Winnecke.

Chairman :—M. Buys Ballot.

After reading and confirming the protocol of the first meeting the list of the documents presented to the Congress was communicated.

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2nd Meeting. Documents received. p. 74.

Documents.

1. Mr. SCOTT handed in a communication from the British Meteorological Society, containing a report on several questions of the Leipzig programme, which had been discussed at certain meetings of that society.

2. Documents relating to the establishment of Meteorological Stations in China. (40 copies.)

3. Letter from the Astronomer Royal relative to the establishment of Meteorological Stations in China. (40 copies.)

4. Statistique de Servie. 2me livraison, redigée par W. Jakschitsch. (15 copies.)

5. Rev. F. W. Stow. An Account of some Experiments on Solar Radiation made at Harpenden, Herts. (8 copies.)

6. Symons. Description of Rain Gauges used in the Experiments at Strathfield Turgiss, Winchfield, Hampshire. (50 copies.)

7. Prestel. Ergebnisse der Beobachtungen und Erfahrungen, betreffend die Sturmwarnungen und die Sturmsignale. (25 copies.)

8. Zurcher & Margollé. Discours du Commodore Maury. (6 copies.)

9. Wild. Probe einer Anordnung des Druckes der Beobachtungen für das Jahrbuch. (30 copies.)

10. Poey. Nouvelle classification des Nuages. (1 copy.)

11. Donati. Sul modo con cui si propagarono i fenomeni luminosi della grande aurora polare del Febbrajo 1872. Firenze, 1873. (30 copies.)

12. Ulysse Marchi. Le thermométrographe à maxima et à minima imaginé et construit par U. M. Florence, 1872. (40 copies.)

13. Wild. Anhang zu den Annalen des physikalischen Central-Observatoriums für 1872. Meteorologische Beobachtungen nach graphischen Instrumenten und magnetische Beobachtungen in St. Petersburg. (30 copies.)

p. 70. 14. M. JELINEK handed in a printed circular of Professor R. Wolf, of Zürich, to the members of the Meteorological Committee of the Swiss Natural History Society and on the duties of the delegates of Switzerland at the Meteorological Congress.

p. 71. 15. The same. A letter to himself from Professor E. Plantamour, of Geneva, on the foundation of an International Central Establishment for Meteorology.

p. 87. 16. The same. A paper from Mr. G. J. Symons, of London, respecting the method adopted in England for the observation of Solar Radiation.

p. 86. 17. The same. A paper from Mr. G. J. Symons respecting the Rain gauges used in England.

p. 84. 18. Mr. SCOTT handed in a communication from Mr. G. T. Kingston, Director of the Meteorological Office in Canada, respecting the most suitable exposure of thermometers.

19. The same. A letter from Surgeon-Major Black, of Edinburgh, containing the description of a Rain gauge for use at sea.

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20. The CHAIRMAN submitted a communication from Prof. G. Cantoni containing his reply to the questions relating to the calculation of Temperature and Humidity. 2nd Meeting. Documents received. p. 80.

M. DONATI submitted a centigrade thermometrograph by U. Marchi of Florence for inspection.

The CHAIRMAN announced that M. Fradesso da Silveira regretted being prevented by the state of his health from taking part regularly in the proceedings of the Congress, and from having his name placed on any of the sub-committees which were to be formed.

The next business was the reading of the provisional and adoption of the definitive Bye-laws. Bye-laws, p. 40.

In § 6 of the provisional bye-laws Mr. SCOTT proposed to insert after the first sentence, "If the votes be equal, the vote of "the Vice-President in the chair shall decide."—Adopted.

In § 7. M. BUYS BALLOT proposed to substitute for the word "chosen" the word "confirmed."

M. NEUMAYER preferred to leave the paragraph in its existing form; for he wished that the Sub-Committees should be chosen by the Congress, and should be given power to add to their numbers.

M. JELINEK proposed to phrase the whole paragraph as follows: "For certain questions in the programme sub-committees "will be appointed, whose members will be nominated by the "Bureau and confirmed by the Congress."

§ 7 was adopted in this form.

Accordingly the Bye-laws run in the form given in the Appendix. (Appendix 1 to Protocol No. II.) p. 40.

The Congress next proceeded to the discussion of the *Programme of present proceedings*. The Organization Committee nominated at Leipzig in 1872 had, with the assistance of MM. Buys Ballot, Neumayer, and Scott, proposed a provisional programme for the present proceedings (in connexion with the subjects discussed at the Leipzig Conference), containing five headings and 28 separate questions. Programme, p. 41.

In the discussion as to the adoption of this provisional programme, or of possible changes in it,

M. PLANTAMOUR asked permission to speak. He said that among the subjects included in the programme a very important one was not mentioned, which if it were first brought forward, would render the discussion of several of the individual questions superfluous, and thus would shorten the proceedings. This is the foundation of a Central Meteorological Institute. He proposed to place this question as the first on the programme. International Institute. pp. 27, 50, 71.

M. BRUHNS expressed himself against this proposal inasmuch as the question was virtually one of organization, and so could best be treated under the 5th heading (Organization) as Question 25*a*.

M. WILD supported this amendment.

M. HOFFMEYER was of opinion that the main object of the Congress was to establish something of an International cha-

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2nd Meeting. Programme, International Institute.

racter. This might be brought about in the following way Certain stations in the Organization of each country might be designated as International stations, while the remainder might remain, as heretofore, national or local.

M. BUYS BALLOT wished that the provisional Programme should be definitely adopted, and that any new proposal, like this of M. Plantamour's, should be introduced as an Appendix to the Programme.

M. JELINEK considered the question raised by M. Plantamour to be the most difficult and important of all. It therefore could not be discussed at once at a general meeting, but must be prepared by deliberation in sub-committees, and meantime there was time to proceed to the consideration of the other less important questions.

Mr. BUCHAN agreed on the whole with M. Jelinek. He considered it better to keep to the programme which was before the meeting, inasmuch as thereby a gradual approach was made to the most important questions of organization, and so many difficulties would be removed out of the way.

M. RUBENSON also wished that the programme should be maintained, but that most of the questions should be considered from two distinct points of view, the international and the national, just as M. Hoffmeyer had proposed a corresponding subdivision of the stations.

Mr. SCOTT remarked at this juncture, that though he was present as representative of his Government, that Government would not consider itself as *bound* by any of the decisions of the Congress.

A proposal from M. WILD, to refer the question of the organization of an International Institute to the sub-committee to be appointed for Weather Telegraphy and Maritime Meteorology was rejected, M. NEUMAYER having expressed himself against it, inasmuch as this sub-committee which had already more than enough to do, would be entirely unable to undertake this discussion.

M. DONATI remarked that a proposal something like that of M. Plantamour was already contained in Question 28 of the programme, viz., the proposed nomination of an International Committee to carry out the resolutions of the Congress, and that accordingly M. Plantamour's proposal might be treated as Question 29, as a sequel to Question 28.

A division was taken on the question whether the proposal for the establishment of an International Institute should be included in the programme itself or as an appendix to it, and the matter was decided in favour of the former alternative.

Sub-committees.

The CHAIRMAN remarked that the permanent committee in making arrangements for the discusion of the 28 questions of the programme had made the proposal to refer the majority of the questions to sub-committees, and to discuss at general meetings only a few which were specially mentioned.

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In general accordance with this proposal the Congress decided that the questions to be considered at general meetings should be 1 (Barometer), 17 (Units of Scale), 19, 20 (Mean and Normal Values), 26 and 27 (Publications). All other questions were to be referred to several sub-committees of which the following is a list :— 2nd Meeting. Appointment of Sub-committees.

I. Questions 2–6 (Thermometer).
II. „ 7–9 (Wind).
III. „ 10, 11, 14 (Rain and Evaporation).
IV. „ 18 (Times of Observation).
V. „ 21, 22 (Weather Telegraphy, Maritime Meteorology).
VI. „ 23–25 (Organization).
VII. „ 28 and M. Plantamour's proposal (carrying out the Resolutions of the Congress,—International Institute).

On Questions 12, 13, 15, 16 (Hail, Thunderstorms, Cloud), there was a report from the Committee appointed last year at Leipzig (Ebermayer, Schoder, and Sohncke) so that no new sub-committee was required for these matters at present.

The CHAIRMAN inquired if any delegate wished to propose additions to the programme.

Mr. CAMPBELL stated that he was commissioned from the Inspector-General of Customs in China (Mr. Hart), who intended to organize meteorological stations in that country, which would be in connection with Japanese, Russian, Spanish, Dutch, French, and English-colonial stations, and he hoped that this subject might be admitted to form a part of the deliberations of the Congress. China.

M. JELINEK thought that a special sub-committee should be appointed for this question, and

M. NEUMAYER supported the proposal.

The Congress decided to nominate this sub-committee. No. VIII. (for Chinese stations).

M. SOHNCKE remarked that no notice of self-recording instruments appeared in the programme and wished to see the following question included in the programme :— Self-recording instruments.

> "What self-recording instruments have been found to be the best hitherto?"

Mr. SCOTT thought the question of too great compass and also to be unripe for decision as yet.

MM. JELINEK and NEUMAYER expressed themselves to the same effect. They thought it desirable that the directors of central institutes should publish their experiences of their self-recording instruments in greater detail than has hitherto been the practice, giving the comparisons of the data of the self-recording instruments with the original eye-observations. The result would be that a future Congress would have sufficient material for a consideration of the question.

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2nd Meeting. Self-recording instruments.

M. BRUHNS proposed that a general meeting should be appropriated to scientific communications on the experience gained of self-recording instruments.

M. SOHNCKE assented to this proposal, withdrawing his former motion as too wide in its scope.

M. WILD supported the wish expressed by M. Jelinek. On a division the proposal of MM. Bruhns and Sohncke was not adopted.

p. 41. Thereupon the Programme for the proceedings of the Congress was adopted in the form in which it appears as Appendix 2 to Protocol No. II.

M. JELINEK brought forward two more proposals as additions to the programme respecting an interchange of reports from the central offices on the condition of meteorological investigations and publications, as well as respecting the existence of long continued series of observations.

Both proposals were to be submitted in writing at the next meeting.

Sub-committees.

The sub-committees were then appointed. This was effected by the several delegates, who wished to take part in the deliberations on the respective questions, volunteering to act upon the sub-committees. The eight sub-committees were accordingly nominated as follows :—

Sub-Committee I.

Questions 2–6 (Thermometers).
President :—M. Wild.
Reporter :—M. Plantamour.
MM. Bruhns, Buchan, Cantoni.

Sub-Committee II.

Questions 7–9 (Wind).
President :—Mr. Scott.
Reporter :—M. Hoffmeyer.
MM. Coumbary, Mohn, Rubenson, Wild.

Sub-Committee III.

Questions 10, 11, 14 (Rain and Evaporation).
President :—M. Plantamour.
Reporter :—M. Ebermayer.
MM. Buchan, Schenzl, Schoder, Wild.

Sub-Committee IV.

Question 18 (Hours of Observation).
President :—M. Plantamour.
Reporter :—M. Hann.
MM. Coumbary, Schoder.

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2nd Meeting. Sub-committees.

Sub-Committee V.

Question 21, 22 (Weather Telegraphy and Marine Meteorology).
President:—M. Buys Ballot.
Reporters:—MM. Scott and Neumayer.
MM. Bruhns, Campbell, Donati, Hoffmeyer, Mohn, Müller, Rubenson.

Sub-Committee VI.

Questions 23–25 (Organization).
President:—M. Bruhns.
Reporter:—M. Wild.
MM. Buchan, Buys Ballot, Cantoni, Ebermayer, Neumayer, Schenzl, Scott.

Sub-Committee VII.

Questions 28, 29 (carrying out Congress Resolutions).
President:—M. Plantamour.
Reporter:—M. Hoffmeyer.
MM. Buys Ballot, Mohn, Rubenson.

Sub-Committee VIII.

(China.)
President:—Mr. Buchan.
Reporter:—Mr. Scott.
MM. Buys Ballot, Campbell, v. Czelechowsky, Wild.

The CHAIRMAN requested the sub-committees to come together immediately after the close of the sitting, and announced the Agenda for the third general meeting to be held on Friday the 5th, at 10 a.m., viz.:—

1. Official business.
2. Consideration of Questions 12, 13, 15, 16, and, if time permitted, also of 1 and 17 of the Programme.

The sitting was adjourned at 1.30 p.m.
Verified at the meeting of the 5th September by the Chairman.
ROBERT H. SCOTT.

Protocol of the Third Meeting, September 5, 10.15 a.m.

3rd Meeting.

PRESENT:

Delegates:—MM. Bruhns, Buchan, Buys Ballot, Cantoni, Coumbary, Czelechowsky, Donati, Dörgens, Ebermayer, Fradesso da Silveira, Gloesener, Hann, Hoffmeyer, Jelinek, Lorenz, Mohn, Müller, Neumayer, Plantamour, Quetelet, Rubenson, Schenzl, Schoder, Scott, Sohncke, Wild, Winnecke.
Visitors:—MM. Köppen, Weiss.
Chairman:—Mr. Scott.
The Protocol of the second meeting was read and confirmed.

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3rd Meeting.

The CHAIRMAN read a telegram from Geheimrath Dove at Berlin, expressing his thanks to the Congress.

Hail.

In accordance with the Agenda the discussion of Question 12 of the Programme was commenced.

It runs as follows:—

> Is it desirable in giving the falls of Hail to draw a distinction between "Graupel" and true Hail?

p. 42.

At the suggestion of M. BRUHNS the respective portion of the report of the sub-committee nominated at Leipzig in 1872 (Ebermayer, Schoder, Sohncke) hereto appended (Appendix 1 to this Protocol) was read.

After a long discussion on this question, in which especially MM. WILD, SCOTT, QUETELET, SOHNCKE, EBERMAYER, BRUHNS, HOFFMEYER and JELINEK took part, the following proposal made by WILD and amended by JELINEK was adopted:—

> Hail is to be described as a precipitation of frozen water, in which the stones attain such a magnitude that they may be expected to do damage to agricultural products.

Thunderstorms, p. 43.

The next subject on the Agenda was Question 13 of the Programme.

> *a.* In counting Thunderstorms, should the Storms as such or the Days of Storm be given?
>
> *b.* In what way should the instances of Sheet-lightning be noticed?

The report of the above-named Leipzig Committee, in reference to *a*, was read, and after some remarks by MM. BRUHNS, BUCHAN, PLANTAMOUR and QUETELET, the recommendations of the sub-committee were adopted.

> In order to obtain values which admit better of comparison it is recommended only to count the Days of Thunderstorms, but this is not intended to prevent individual observers from inserting in the column of "Remarks," in addition the number of the Storms, the time of their commencement, their duration, direction of motion, &c.

In reference to 13*b* the respective portion of the report of the sub-committee was read, and finally the proposal of the majority of the sub-committee, supported by MM. WILD and QUETELET was adopted:—

> As days of storm only those are to be noted on which both Lightning and Thunder have been observed. If only Lightning without Thunder has been noticed the entry for the day must be Sheet Lightning.

At this point M. NEUMAYER communicated some experiences of his own regarding special electrical phenomena in connexion

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with this question, and recommended particularly the observations of such sound-phenomena, at the time of electrical discharges, as hissing and a harsh rattle preceding the actual thunder. 3rd Meeting. Thunder-storms.

The first portion of Question 15 was next taken up :— Cloud, p. 44.

> In what way should the proportion of Cloud in the sky be estimated and indicated ?

M. SCHODER read the respective portion of the above-named report of the Leipzig Committee.

M. BUYS BALLOT explained that he had hitherto employed the method of description of the degree of cloud directly opposite to that now proposed, but yet that he was quite ready to introduce the new method if it met with general adoption.

M. QUETELET made an exactly similar communication.

Hereupon the recommendation was adopted in the following words :—

> The degree of cloudiness is to be given by the figures 0–10, in which 0 is to represent a sky quite free from cloud, and 10 an entirely overcast sky.

On this the question was raised by MM. BRUHNS and WILD as to what numerical entries should be made in the cases of slight fog, films of cirrus, &c. &c. Cloud Forms.

Mr. BUCHAN thought it right to describe a Photometer constructed by Mr. Thomas Stevenson, which enables the observer to estimate the intensity of light and thus to draw approximate conclusions as to the density of the cloud-covering.

M. PLANTAMOUR pointed out the insufficiency of such an instrument and indicated (followed by M. EBERMAYER) the importance of minute particulars respecting clouds in regard of their form and other details.

M. HOFFMEYER remarked that in Denmark the observers noted not only the amount of cloud, but also the general colour of the sky, and

M. BRUHNS stated that he considered a discussion of cloud-forms at a general meeting as premature.

The meeting then decided to refer the points which had just been raised in reference to cloud-form to a sub-committee.

M. LORENZ wished that it should be decided by the same sub-committee, whether or not it would not be possible to indicate a uniform thin coating of cloud, otherwise than by lowering the figure for the degree of cloud, for by the usual method of procedure the amount of superficial extension of the cloud was confounded with the thickness of the cloud strata.

M. PLANTAMOUR recommended to the consideration of the same sub-committee "Höhenrauch," and Mr. BUCHAN the question of whether in case of "blue sky" the horizon is or is not free from haze or mist.

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3rd Meeting. Cloud.

At the suggestion of the CHAIRMAN, supported by M. NEUMAYER, the subject was referred again to the Leipzig Committee, with the request that they would co-opt members as requisite, and present a report as soon as possible, together with the second part of the report of Question 15, which could not be discussed at the present meeting.

Atmospheric Electricity.

In accordance with the Agenda, Question 16 was next discussed :—

> Should other Meteorological Elements than those already enumerated, *e.g.*, Atmospheric Electricity, Ozone, &c., be included in the scope of normal observations, and what are the best instruments for observing them?

p. 45.

M. SOHNCKE reported for the Leipzig Committee on Atmospheric Electricity, and recommended that observations of it should only be made at Central Observatories, and, as the best form of apparatus, Sir W. Thomson's electrometer, with water (or smoke) as collector.

M. CANTONI remarked that he had obtained very good results with Palmieri's electrometer, and he accordingly recommended it. On the other hand M. QUETELET recommended Peltier's electrometer, which had been used at Brussels for 30 years with good results.

M. BUYS-BALLOT confirmed this statement from 20 years' personal experience.

> It was resolved in accordance with the proposal of the subcommittee that the institution of observations on Atmospheric Electricity be recommended only for Head Observatories, and that the decision as to the choice of the best methods of observation and of the most suitable instruments, must be left to them.

Ozone, p. 47.

M. EBERMAYER reported on Ozone, and recommended that observations should only be taken at Central Observatories, and on the decimal scale, but with a different scale of colours than that given by Schönbein. Despite the imperfection of existing ozonometers, observations should be conducted for the future inasmuch as they undoubtedly yield useful *relative* values.

M. WILD said that according to Dohrandt's investigations the methods which had been as yet introduced were insufficient, inasmuch as they gave contradictory results, so that the only recommendation possible was that better modes of observation should be devised.

Mr. SCOTT mentioned the wish of the Army Medical Department to learn the views of the Congress on Ozone observations, and expressed himself at the same time against the modes of observation hitherto employed as not ensuring sufficient certainty.

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M. NEUMAYER spoke from his own five years' experience in Australia, that all the Ozone papers now in use were insufficient for observations. Observations conducted by him at sea, and in all climates, in rigid adherence to the rules, proved that the evaporation of the iodide of potassium on the strip of paper materially affected the results.

M. EBERMAYER stated that he had obtained in a six years' course of observation good results, which allowed him to recognise an indubitable connection with atmospheric humidity, and with the amount of electricity in the air.

M. CANTONI admitted the existence of such a connection, on the ground of seven years' observations, but considered the influence of Light, Temperature, and specially of the motion of the air as predominant. He supported M. Wild's proposal for renewed experiments.

M. NEUMAYER further remarked that he had not been able to obtain any trustworthy results in spite of three-hourly observations, and recommended eudiometrical observations.

M. WILD communicated his experience that exposed ozone papers had become dark in six hours, but that after the lapse of six more hours the colour had been discharged.

Mr. BUCHAN said that observations had been made in Scotland for 18 years at many stations, and that the results had been decidedly unsatisfactory. Four years ago a Committee had been nominated for the special purpose of enquiring into the state of Ozone observations. The Committee, after numerous observations with various kinds of paper, experiments and enquiries, came to the conclusion that accurate qualitative and quantitative methods for the determination of the ozone present in the air are still wanting. The uncertainty of ozone observations had induced the President of the Scottish Meteorological Society (the Marquis of Tweeddale), to devote 100*l.* for ozone investigations, and the Committee had placed themselves in communication with Professors Andrews, Belfast; Tait and Crum Brown, Edinburgh.

The Congress hereupon expressed its recognition of the munificent liberality of the Marquis of Tweeddale in fostering scientific investigation.

After another reply from M. EBERMAYER, the following proposal made by M. WILD was adopted:

> The existing methods of determining the amount of Ozone in the atmosphere are insufficient, and the Congress therefore recommends investigations for the discovery of better methods.

In continuation of Question 16, M. EBERMAYER recommended that measurements of water in the soil, and of the amount of water draining through the soil, as well as of the amount of carbonic acid in the air contained in the soil, &c., although in themselves important, yet, as not belonging to Meteorology, should

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3rd Meeting. be excluded from the present discussions, and the meeting adopted this proposal.

Vertical currents of air. In connection with Question 16, M. DONATI stated that he had recently erected a wind vane for the determination of the direction in the ordinary sense, and of its deviation from the horizontal plane, and had already made some observations therewith.

Hereupon, in consideration of the lateness of the hour, the business standing on the Agenda paper was adjourned, and before the close of the sitting the two proposals announced by M. Jelinek at the previous meeting, and two new proposals from M. Buys Ballot were read. The scope of the latter is, on the one hand, the foundation of observing stations on islands and in distant localities, and on the other the organization of establishments to facilitate the exchange of publications.

pp. 47, 48. All the proposals were appended to the Protocol as Appendices 2, 3, and 4.

The CHAIRMAN fixed the next meeting for Monday, September 8, 10 a.m., and announced the following Agenda :—

1. Official communications.
2. Discussion of Question 15 (Part 2), then 1, 17, 19, 20, 26, 27.
3. Reports of Sub-committees, if any.

The sitting was adjourned at 1.20 p.m.

Verified at the meeting of the 8th September, by the Chairman.

C. BRUHNS.

4th Meeting.

Protocol of the Fourth Meeting, September 8, 10.20 a.m.

PRESENT:

Delegates :—MM. Bruhns, Buchan, Buys Ballot, Campbell, Cantoni, Coumbary, Czelechowsky, Donati, Dörgens, Ebermayer, Fradesso da Silveira, Hann, Hoffmeyer, Jelinek, Lorenz, Mohn, Müller, Neumayer, Plantamour, Quetelet, Rubenson, Schenzl, Schoder, Scott, Sohncke, Wild, Winnecke.

Visitors :—MM. Köppen, Nordenskiöld.

Chairman :—M. Bruhns.

The meeting was opened, and the Protocol of the third meeting was read and confirmed, and MM. BUYS BALLOT, QUETELET, and FRADESSO, at the suggestion of the first-named gentleman, and with reference to the first portion of Question 15 of the programme (*vide* Protocol of third sitting [p. 15]), expressed their readiness to commence the new notation of the amount of cloud at their observatories on the 1st January 1874, if by that epoch it had been generally adopted.

The following official communications were made :—

1. M. BUYS BALLOT has withdrawn the second of the two proposals made by him at the third meeting (Central Establishment for the exchange of publications), inasmuch

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as its real subject would be considered at the general meeting in connexion with Question 27. 4th Meeting.

2. The CHAIRMAN presented as a visitor Prof. Nordenskiöld, who had received instructions from the Society of Science of Finland to attend the meetings of the Congress.

3. The CHAIRMAN stated that M. Schmidt (Athens) had stated by letter that he was unable to be present at Vienna in time.

4. Communications received:— Communications received.

A letter (from Grenoble) from M. Harold Tarry, Inspector of Finances, Paris, to the Congress, on the questions to be discussed at the present meeting.

From M. Fradesso da Silveira:

The Annals of the Observatory of the Infante Don Luiz at Lisbon, years 1863–71.

Photographs of the Central Physical Observatory, and of the instruments employed at it.

Graphical representations of the daily and yearly march of the meteorological and magnetic elements.

Specimens of the curves yielded by the photographically registering instruments, and photographs of the sun and of the larger groups of spots.

From M. Nordenskiöld:—

Observations made at the Magnetic and Meteorological Observatory of Helsingfors, Vol. V., Helsingfors, 1873 (containing Air Temperature observed every 20 minutes from 1 May 1848 to 31 December 1856).

Climatological reports in Finland, Part I., 1846–55; II. Meteorologiska Anteckningar, made by Adolf Moberg, Helsingfors, 1871.

From Dr. P. Schreiber, on the trustworthiness of the Aneroid. Munich. 1873.

The Congress proceeded to the next entry on the Agenda, the discussion on Part II. of Question 15. Clouds.

> Is it desirable to introduce for Clouds, Hydrometeors, and for other extraordinary phenomena, symbols which shall be independent of the language of particular countries and therefore universally intelligible?

This was opened by M. SCHODER, as Reporter, by reading the report (Appendix 1 to Protocol No. IV.) and sketching the respective symbols. p. 48.

M. FRADESSO remarked, in a speech of some length, that the Congress should divide the questions which were before it into two categories, those eminently of organization, and those more of secondary importance. In his opinion it was the chief business of the Congress to bring the former to an issue. Proposed reconsideration of Programme.

M. BUYS BALLOT spoke to similar effect, and made the proposal that on all questions which referred to instruments and observations, the reports only should be read, but that no discussions or

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4th Meeting. divisions should take place on them, in order that time enough should be left for the treatment of questions involving organization. This proposal was lost.

Symbols for Hydrometeors, p. 48. After a long debate on the advisability of and the difficulty of the adoption of symbols, in which MM. QUETELET, MOHN, PLANTAMOUR, DONATI, JELINEK, SCOTT, CANTONI, and WILD took part, M. Jelinek's proposal that all delegates should be provided with lithographs of the symbols in use in various countries, and those proposed by the sub-committee, was agreed to, with the addition, by M. Wild, that the division on their adoption should be taken at one of the later meetings. Thereupon the second portion of the report relating to the entry of Fog, Höhenrauch (Dust haze), and of Cloud (*see* Appendix 1 to Protocol No. IV.), was read, and the recommendations of the sub-committee were adopted without alteration.

Barometers. The next matter on the Agenda was then taken up (Question 1 of the Programme).

> What is the best form of Barometers for stations of the second order?
>
> Is the use of Aneroids for such stations admissible?

MESSRS. SCOTT and BUCHAN recommended the Kew barometer as an excellent and cheap barometer, and MM. WILD and QUETELET also discussed the question of what barometers should be recommended for adoption.

Finally a proposal of M. Jelinek's was adopted.

> The reply to the question respecting the mercurial barometer is to be postponed, inasmuch as it is desirable previously to obtain reports from all directors on the barometers employed in their systems, in reference to construction and price.

Aneroids. With regard to aneroids, M. WILD communicated briefly some results according to which Naudet's Aneroids might be admitted with advantage, at least as interpolation or reserve instruments, at ordinary stations.

MM. BUCHAN, FRADESSO, BRUHNS, and CANTONI made observations bearing on the question, and M. BRUHNS having drawn attention to Schreiber's paper, M. Wild's proposal was adopted.

> Aneroids should not be employed at stations where there is no other barometer, but they are admissible as interpolation instruments alongside of the mercurial barometer.

Units of Measure, p. 49. On Question 17, which was the next for discussion, M. Wild reported. The report, containing the views of several Meteorologists, is given as Appendix No. 2 to the Protocol of the meeting.

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Question 17 is as follows: 4th Meeting. Units of Measure, p. 49.

> Is it desirable to introduce the same Units of Measure (viz., of Length, Degrees, and Time) in meteorological inquiries in all countries, or is it sufficient to lay down certain fixed rules for the conversion of the different measures employed in the several countries?

The discussion mainly turned on the question, whether or not, on political or other grounds, it was advisable to support the introduction of uniformity of measures.

MM. SCOTT, WILD, DÖRGENS, BUCHAN, RUBENSON, QUETELET, NEUMAYER, and BRUHNS, took part in it.

It was unanimously admitted, that all action must be confined to an expression in a decided form of what was most desirable.

In this sense M. JELINEK made the following proposal:—

1. For observations as well as for publications the use of the same units of measure is desirable.
2. The Congress expresses its conviction, that among all the existing systems of measure, the Metric has the best prospect of universal adoption.
3. The Congress declares it to be most desirable, if it be not possible to introduce uniform measures at present, to use henceforth only Metric and English measures (with Celsius and Fahrenheit scales).
4. All action is to be supported which tends to the introduction of the uniform Metric system.

After a short debate the 1st section of the proposal was adopted unanimously, and the 2nd and 4th by all the votes except that of Mr. Scott. The 3rd by all votes except that of M. Quetelet, who wished to exclude all scales except the Metric.

The Congress then confirmed unanimously the resolution adopted at the Leipzig Congress, that the results of observations or the means should be published in the Metric scale, as well as in their original scales.

Mr. SCOTT observed in regard to this resolution that he had begun to carry it out in the Quarterly Weather Report, ever since the time of the Leipzig Conference.

Thereafter M. HOFFMEYER, as Reporter, read the report of the seventh sub-committee (printed as Appendix 3) on M. Plantamour's proposal as to the establishment of a Central International Institute. International Institute, p. 50.

The next meeting was fixed for Wednesday, September 10, 10 a.m.

Agenda:

1. Official communications.
2. Election of the Editing Committee for the publication of the Proceedings of the Congress (§ 8 of the Bye-laws).

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4th Meeting.

3. Discussion of the report of the 7th sub-committee (M. Hoffmeyer, Reporter).
4. Consideration of the Questions 17*b*, 19, 20, 26, 27, and sections 1, 2, 3 of the Appendix to the programme.

Close of the meeting, 1.30.

Verified at the meeting of September 10, by the Chairman.

H. WILD.

5th Meeting.

Protocol of the Fifth Meeting, September 10, 10.20 a.m.

PRESENT:

Delegates:—MM. Bruhns, Buchan, Buys Ballot, Cantoni, Coumbary, Czelechowsky, Dörgens, Donati, Ebermayer, Glösener, Hann, Hoffmeyer, Jelinek, Lorenz, Mohn, Müller, Neumayer, Plantamour, Quetelet, Rubenson, Schenzl, Schoder, Scott, Sohncke, Wild, Winnecke.

Visitors:—MM. Köppen, Nordenskiöld, Wrangel.

Chairman:—M. Wild.

Communications received.

The Protocol of the 4th meeting was read and confirmed, and the Chairman read the following communications:—

1. A letter from Vice-Admiral Baron Wüllerstorf-Urbair, in which he expressed his lively interest in the objects of the Congress, and his regret at being unable to take part in its proceedings.
2. A letter from Director A. Aguilar, in which he expressed his regret at being unable to take part in the proceedings of the Congress, and furthermore contained a reply to the Questions of the Leipzig Conference.
3. A communication from the Austrian "Verein der Freunde der Naturwissenschaften," with the request for information as to the form in which, in future, meteorological observations will be registered, in order that the arrangements of the society might be regulated accordingly.
4. M. BUYS BALLOT handed in, for distribution to the members of the Congress, several copies of a comparison of the differences of Pressure, with the Direction and Force of the Wind, observed at the Helder, Gröningen, and Flushing.

Thereupon Baron Wrangel, who had been deputed by the Imperial Hydrographic Office of Russia to attend the meetings as a visitor, was presented.

Corrected copies of the list of delegates, and facsimiles of the various symbols for Rain and similar phenomena, were distributed.

The CHAIRMAN distributed the first proofs of some of the protocols of the meeting which were in type, and proceeded to the discussion of the first matter on the Agenda for the day.

Election of the Editing Committee for the printing and distribution of the Protocols and Proceedings of the Congress.

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5th Meeting. Editing Committee.

M. BRUHNS proposed to nominate MM. Jelinek, Hann, Müller, and Neumayer as the Editing Committee.

M. JELINEK requested that his name might be omitted, at the same time expressing his readiness to assist the committee in the discharge of their duty to the utmost of his power, if necessary.

The meeting then unanimously elected MM. Hann, Müller, and Neumayer as members of the Editing Committee.

M. WILD proposed that the protocols should be published in the French language also.

Two editions, German and French.

It was then decided that the proceedings of the Congress and the reports of the Sub-Committee should be published in the German and French languages, and M. QUETELET declared his readiness to undertake the editing of the French version.

The communications which are to be printed are only to be given in the language in which they are framed.

English translation.

Mr. SCOTT offered to publish the protocols in English also, as he had done in the case of the Leipzig Proceedings.

The Congress accepted this proposal with thanks.

The next matter on the Agenda, the continuation of Question 17 (Units of Measure), was passed over, inasmuch as the question of Time was to be treated in Questions 19 and 9.

In Question 19 :—

Calculation of Means.

What are the rules, and what the intervals of Time for which the means of the several Meteorological Elements should be calculated?

Which is the better plan, to begin the meteorological year with January, or with December?

M. BRUHNS opened the discussion with the proposals :—

As units should be chosen,

1. The Mean Solar Day, reckoned from midnight to midnight, of the place of observation.
2. The Civil Year.
3. The Months; in which case, however, January 31 and March 1 are to be reckoned with February.
4. Dove's Five-day Means (73 per annum).

After a full discussion with especial reference to the 3rd and 4th sections of the proposal, in which part was taken especially by MM. BUCHAN, BUYS BALLOT, CANTONI, DONATI, DÖRGENS, HOFFMEYER, JELINEK, MOHN, PLANTAMOUR, QUETELET, SCOTT, and WILD, section 1 was adopted unanimously, section 2 by all the votes except three. Before dividing on the 3rd section, the 4th was brought on for division, and was considered under two sub-heads.

Five-day Means.

(*a.*) The calculation and publication of 5-day means of Temperature is recommended, in each system of observation, for a considerable number of stations, the choice of which is left to the Central Institute of the country.

This proposition was adopted by all votes except three.

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5th Meeting. Five-day Means.

(*b.*) Dove's 5-day means (73 in the year) are to be adopted.

The division was by name, and the proposition was adopted by 15 votes to 9. M. Buys Ballot abstained from voting.

Monthly Means.

Hereupon the division was taken on section 3 of M. Bruhn's proposal, and it was decided to abide by the Civil Month everywhere, and to calculate the Monthly means as pure arithmetical means. Moreover, the mean of the 12 Monthly means is to count as the mean of the Year.

M. BRUHNS further proposed :—

Daily Means.

1. To count the interval of 24 hours in the following way: the first 12 hours, from 1–12, as Forenoon, the following 12 hours, from 1–12, as Afternoon.
2. To count midnight (12 o'clock midnight) always as the end of the day, and similarly noon (12 o'clock noon) as the close of the forenoon.

The first of these proposals was adopted unanimously without discussion. With reference to the second proposal, M. RUBENSON remarked that it might be difficult to introduce this practice at observatories where it did not previously exist.

After some further explanations on the part of MM. QUETELET, PLANTAMOUR, BRUHNS, DONATI, and JELINEK, the proposal was adopted by all the votes except four.

The next question on the Agenda was No. 20.

"Lustral" Periods.

In what manner and for what intervals are the normal values for the individual Meteorological Elements to be deduced?

M. BRUHNS recommended in accordance with the resolutions passed at Leipzig, to choose as the periods for calculation of normal values, intervals of five years (lustra), so that the next Lustrum should begin with Jan. 1, 1876.

M. QUETELET remarked that the calculation of lustra had been introduced in Brussels ever since the year 1833, and the proposal was unanimously adopted, as was also an additional proposal of MM. Donati and Jelinek, in accordance with which it was recommended that central institutions should recalculate their old observations in accordance with the proposal, as regards the more important data.

Owing to the lateness of the hour the reports of the second and third sub-committees (see Appendices 1 and 2 to Protocol No. V.), and of the latter only the portion which related to Question 10 (Raingauges) were read by the Reporters (MM. Hoffmeyer and Ebermayer), and the next general meeting was fixed for the next day, September 11th, 10 a.m.

Agenda—

1. Official communications.
2. Reading of the reports of sub-committees III. and IV.

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3. Discussion of the reports of the sub-committees which had been already read, and 5th Meeting.
4. Discussions of the Questions 26–27; viz., the Publication and Exchange of Observations, if time permitted.

Close of the sitting at 1.15 p.m.

Verified at the meeting of 11th September 1873, by the Chairman.

BUYS BALLOT.

Protocol of the Sixth Meeting, Thursday, 11th September 1873, 10.15 a.m.

PRESENT:

Delegates:—MM. Bruhns, Buchan, Buys Ballot, Campbell, Cantoni, Coumbary, Czelechowsky, Dörgens, Donati, Ebermayer, Hann, Hoffmeyer, Jelinek, Mohn, Müller, Myer, Neumayer, Plantamour, Quetelet, Rubenson, Schenzl, Schoder, Scott, Sohncke, Wild, Winnecke. 6th Meeting.

Visitors:—MM. Köppen, Nordenskiöld, Wrangel.

Chairman:—M. Buys Ballot.

The protocols of the former meeting were read and confirmed.

THE CHAIRMAN announced that additional proofs of the protocols of the earlier meetings had been sent in. He welcomed Brigadier General Albert J. Myer, Delegate from the United States of N. America, who was present for the first time at the deliberations of the Congress.

In accordance with the Agenda, the report of the third sub-committee on Rain (Question 11, Appendix 2 to Protocol No. V.), and Evaporation (Question 14, Appendix 2 to Protocol No. VI.), were read by M. Ebermayer, and afterwards the report of the fourth Sub-committee on Question 18 (Hours of Observation) was read by M. Hann (Appendix 1 to Protocol No. VI.).

The discussion of the report of the second sub-committee (Wind: Questions 7–9, Appendix 1 to the protocol of the fifth general meeting), which had been already read by the Reporter, M. Hoffmeyer, was undertaken. Wind, p. 51.

The questions were as follows:

7. In what way can uniformity in describing the Directions of the Wind be attained?

Is the deduction of the Mean Direction of the Wind by Lambert's formula desirable?

Is it desirable or not to include very light winds (force 0) in constructing Wind-Roses for the Direction of the Wind?

8. What scale should be employed for the Force of the Wind when it is determined, not by actual measurement, but only by estimation?

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6th Meeting. Wind, p. 51.

9. Is it desirable to introduce simple dial-instruments for determining the Velocity of the Wind?

What units should be taken for the discussion of the Velocity of the Wind?

On the proposal of the sub-committee to introduce English designations for the Direction of the Wind (abbreviated N. E. S. W.), M. DONATI remarked that he could not agree to adopt it in so far as it had to deal with *national* observations. The reply to this was, in the first instance, that publications of an *international* nature were referred to, and the report of the sub-committee was then adopted unanimously. Similarly, without further discussion, the proposal of the sub-committee to refer the wind to the 16 points only, and in the case of intermediate directions of the wind, to give them alternately to one side or the other, was adopted unanimously.

Considerable discussion arose on the proposal of the Committee with reference to Lambert's formula and MM. PLANTAMOUR and BRUHNS spoke in favour of its conditional employment. M. BUYS BALLOT, although he recognised the theoretical correctness of the formula, felt himself compelled not to recommend it in practice. Finally the proposal of the sub-committee was adopted unanimously.

With reference to the prevalence and the mean force of the various winds, M. RUBENSON recommended their being given in per-centages, in order to afford better means of comparison of results of observations.

M. PLANTAMOUR supported the proposal, while Mr. BUCHAN was ready to allow the giving of per-centages in the discussion, but not in the publication of observations.

On a division the majority of the Congress declared themselves in favour of the proposal of the sub-committee.

The recommendation of the sub-committee to disregard winds of the velocity of less than half a metre per second, and to designate them as Calms, was adopted by all votes to four after certain remarks by MM. QUETELET, JELINEK, BUCHAN, PLANTAMOUR, SCOTT, and the REPORTER.

Similarly the views of the Committee with reference to M. v. Oettingen's proposal were accepted and the proposal was declined.

The Congress then proceeded to discuss the resolution with reference to the general scale for the estimation of the Force of the Wind, and agreed, by all votes except one, to the proposal to introduce as soon as possible at stations of the second order, for the force of the wind, simple instruments proposed by M. Wild and already tested.* On one hand MM. PLANTAMOUR and BRUHNS pointed out the difficulty which observations with such instruments presented at stations of the second order, while, on the other hand, MM. HOFFMEYER, SOHNCKE, and WILD, pointed out in a special way the advantage which would arise if the apparatus

* Supplement No. XI. p. 91.

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were used even only in the day observations, because the observers would thereby get a greater degree of certainty in the estimation of wind force, and so greater uniformity would be obtained. 6th Meeting. Wind.

The recommendation of the sub-committee to give the Velocity of the Wind in metres per second and also that with respect to Tables of Reduction were adopted without discussion.

Finally the recommendations to observe the Direction of Wind in the various strata of clouds were approved by the Congress.

The next subject was the Report of the seventh Sub-committee (carrying out the resolutions of the Congress, and M. Plantamour's proposal repecting the establishment and the maintenance of an International Central Meteorological Institute). International Institute, p. 50.

M. HOFFMEYER read the report (App. 3 to the protocol of the fourth general meeting). M. BRUHNS in a detailed statement explained the difficulties which would be found at the present time in the establishment of such an international institute by co-operation between governments, while the establishment of an institution which should be independent of governments, such as an International Meteorological Society, seemed quite possible and desirable.

M. PLANTAMOUR, on the other hand, pleaded for an Institute, but thought that union was the chief matter, and that the question of form which, at all events, must be left to the committee, was immaterial. Upon this the REPORTER proposed to replace the expression "Institute" by the more general one "Institution," and to choose at a later meeting a committee consisting of five members, which should make all preparations, in order in the course of the year 1874 to carry out the necessary action, and to publish proposals which should eventually be laid before a future Meteorological Congress. This proposal was adopted unanimously.

The report of the third Sub-committee respecting Questions 10–11 of the programme (measurement of Rain and Snow) was then discussed. M. EBERMAYER, the Reporter, read the separate paragraphs of the report (Appendix 2 to Protocol No. V.). The Congress agreed, by all votes to one, to the proposal of the said committee to adopt as the best form for the receiver of the rain-gauge the circular one with the area of one-tenth of a square metre (diameter 14 inches.) Rain, &c. p. 52.

It was also adopted by a majority that the receiver of the rain gauge should be placed at a height of not less than one, and better, of 1½ metre above the ground.

Mr. BUCHAN saw himself compelled to protest against this decision. The height of one foot* had been tested by investigations and experiments made for many years, and as a result it had been generally recommended by the Rain Committee of the British Association.

The recommendations of the sub-committee respecting the stating in all publications the height of the receiver from the ground, and as to the size of the collecting vessel, as well as the

* Note to English edition.—And diameter of gauge from 3 inches upwards.—A. BUCHAN.

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6th Meeting. Rain. p, 52.

best form for it, in order to prevent the evaporation of the water which had been collected, was adopted by the Congress without debate.

With regard to the measurement of the Rain-fall, it was recommended by the Congress, after some remarks from MM. BRUHNS and PLANTAMOUR, to make this, wherever possible, at the close of the fall in question, but on the whole to carry it out at the first reading in the morning, and to put down the quantity measured as belonging to the previous day.

Finally the proposal of the sub-committee to insert in the Remarks, wherever possible, the duration of the fall, in hours, was adopted.

Days of Rain, &c. p. 52.

The discussion on the individual points of Question 11 regarding the entry of days of Rain and Snow was then taken up.

The proposal to introduce symbols which should be adopted by the Congress for the character of the precipitation, in the column intended for Remarks, and to give in the monthly resumé the sum of all the days of rain-fall, and besides that of all the days of snow separately, was adopted after some remarks from MM. QUETELET, PLANTAMOUR, and BRUHNS.

Further it was agreed that the Journal should have two columns, one for the quantity fallen, and one for the depth of the unmelted snow, while the duration of the fall, expressed in hours, was to be noted in the Remarks.

With respect to the information as to the depth of the snow-covering, M. LORENZ urged the importance of such remarks for agriculturists, even in the case where they were only approximations, and MM. BRUHNS, HOFFMEYER, RUBENSON, BUCHAN, SCOTT, and WILD, took part in the debate. The proposal of the sub-committee was adopted, with the addition by M. Lorenz that it should always be noted in the Remarks whether the ground was covered with snow or not.

Finally the concluding proposals of the sub-committee to give the maximum fall in 24 hours of every month were adopted, but the proposal of the sub-committee with reference to the falls under one mm. (0·04 in.) and under ½ mm. (0·01 in.) was only recommended.

THE CHAIRMAN then read the proposal of M. Wild, which had been handed in in the course of the meeting (Appendix No. 3. to Protocol No. VI.), and fixed the next general meeting for to-morrow, the 12th September, at 10 a.m., and the following Agenda for the same :—

1. Official communications.
2. Consideration of the report of the sub-committees on Questions 14, 15*b*, and 18.
3. Consideration of the Questions 26, 27, and the supplements to the Programme.

Close of the sitting at 1.15 p.m.

Verified at the meeting of 12th September by the Chairman.

R. H. SCOTT.

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Protocol of the Seventh Meeting, Friday, 12th September 1873, 10.20 a.m.

7th Meeting.

PRESENT:

Delegates:—MM. Bruhns, Buchan, Buys Ballot, Campbell, Czelechowsky, Cantoni, Coumbary, Donati, Dörgens, Ebermayer, Hann, Hoffmeyer, Jelinek, Mohn, Müller, Myer, Neumayer, Plantamour, Quetelet, Rubenson, Schenzl, Schoder, Scott, Sohncke, Wild, Winnecke.

Visitors:—MM. Köppen, Nordenskiöld, Wrangel.

Chairman:—Mr. Scott.

The Protocol of the 6th meeting was read and confirmed. THE CHAIRMAN read the proposal of Brigadier-General Myer, in the form of a letter (printed Appendix 1 to Protocol No. VII.), with regard to the organization of simultaneous observations at least once a day, and stated that he would enter the discussion of this question on the Agenda for the next meeting.

The first business on the Agenda was the Report of the 3rd Sub-committee (Rain and Evaporation), with special reference to Question 14 (Atmometers), and was read by M. EBERMAYER, Reporter.

Evaporation, p. 53.

The Congress adopted the report of the sub-committee in all particulars, with the addition that the measurements of evaporation, by means of floating apparatus on large surfaces of water, which had been formerly used by M. Neumayer and lately recommended by M. Buys Ballot, should be used wherever possible.

In the second part of Question 15, which referred to symbols, M. WILD proposed, as the delegates were already acquainted with them, that they should be adopted *en masse*. M. PLANTAMOUR pointed out that on the lithographic sketch the signs of the intensity (exponents) 0 and 2 had been omitted. M. CANTONI recommended that a decision should not yet be taken on the symbols. This proposal was in a minority, and the proposal of M. Wild, as well as that of the sub-committee, was adopted.

Symbols for Hydrometeors, p. 48.

M. HANN reported for the fourth Sub-committee respecting Hours of Observation (Appendix 1. to Protocol of the sixth meeting).

Hours of Observation, p. 52.

M. BUYS BALLOT declared that he must recommend the combination 6^h, 2^h, 10^h for observations, as unconditionally the best, but he expressed the wish that if a station had already adopted this or any other combination, it should maintain it unchanged.

M. CANTONI remarked that in Italy the best results had been obtained by combining the hours 9 a.m. and 9 p.m., or 10 a.m. and 10 p.m. in conjunction with the maximum and minimum.

Mr. SCOTT remarked that two observations daily, in combination with maximum and minimum, with respect to Temperature, must be declared to be admissible in regard to volunteer observers. In England, among 50 Fellows of the Meteorological Society, 41 had expressed themselves in favour of only two observations daily (9 a.m. and 9 p.m.).

p. 75.

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7th Meeting.

After a short debate all the proposals of the sub-committee were adopted.

Publications.

The Congress then proceeded to discuss Question 26 (Publications).

M. WILD laid before the Congress a scheme for the publication of the results of observations which had been most carefully devised and prepared by M. Köppen. It was arranged that this should be lithographed by next day, and placed in the hands of the delegates, so that it should be discussed at Monday's meeting.

Distribution of Publications. p. 56.

With respect to Question 27 of the Programme, which was the next for discussion (Notices, and Receipts for Books sent out), M. PLANTAMOUR declared regular receipts unnecessary. M. WILD, on the other hand, thought receipts desirable, and proposed a simple form which had been already used by him, which is appended as a second Appendix to the Protocol of the seventh meeting.

Office for receipt of Publications, p. 48.

At M. BUYS BALLOT's wish, his proposal which had been brought forward at the second meeting with respect to the organization of transmitting offices in all countries was brought on for discussion, and adopted unanimously. For smaller parcels, M. Bruhns's proposal for transmission by book post was recommended; and similarly M. Wild's proposal to send notice of, and receipts for, larger parcels was almost unanimously adopted.

On this the Report of the 1st Sub-committee (Appendix No. 3 to this Protocol), Questions 2–6 (Thermometers and Hygrometers), was read by the Reporter, M. PLANTAMOUR, and it was decided to postpone the reading of the Report of the 8th Sub-committee (China).

THE CHAIRMAN then distributed some copies of the First Report of the Investigations in the German Seas, Berlin, 1873, which had been sent in by Professor Karsten, of Kiel, as a present, and fixed as Agenda for the general meeting of the next day, at 10 a.m., the following matters:—

1. Official communications.
2. Discussion of Question 28 (carrying out the decisions of the Congress), and choice of the five committee-members for the Permanent Committee.
3. Consideration of General Myer's proposal.
4. Discussion of the reports of the 1st sub-committee (Thermometers) and the 8th (Organization of Meteorological Stations in China).
5. Discussion of the supplements to the Programme (proposals of MM. JELINEK, BUYS BALLOT, and WILD).

The wish was then expressed that all the Sub-committees would have their Reports ready for presentation at the next meeting, and the sitting was then closed at 1.15 p.m.

Verified at the meeting of the 13th September by the Chairman.

H. WILD.

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Protocol of the Eighth Meeting, Saturday, September 13th, 10.35 a.m. 8th Meeting.

PRESENT:

Delegates:—MM. Bruhns, Buchan, Buys Ballot, Campbell, Cantoni, Coumbary, Czelechowsky, Donati, Dörgens, Ebermayer, Gloesener, Hann, Hoffmeyer, Jelinek, Lorenz, Mohn, Müller, Myer, Neumayer, Plantamour, Quetelet, Rubenson, Schenzl, Schoder, Scott, Sohncke, Wild, Winnecke.

Visitors: — MM. Köppen, Nordenskiöld, Osnaghi, Ricco, Wrangel.

Chairman:—M. Wild.

The protocol of the previous meeting was read and confirmed.

THE CHAIRMAN introduced Prof. Ricco, of the Royal Observatory at Modena, as a visitor. He then stated that the lithographed schemes for the publications had arrived, and distributed them. He further remarked that it would be necessary to hold two more sittings, the last of which, on M. Schoder's proposal, was fixed for Tuesday morning at 9h. a.m., MM. Donati and Cantoni having alone declared themselves against that proposal.

Carrying out decisions of Congress, p. 59.

Hereupon M. HOFFMEYER read for the 7th Sub-committee the Report on Question 28 (carrying out the decisions of the Congress; Appendix 1. to Protocol of the eighth meeting).

THE CHAIRMAN proposed to proceed at once to the discussion of this question. The contrary proposal of M. Schoder for the postponement of the discussion was declined. The first two points of the report were adopted. With reference to the third point, in regard to the number of members who should form the Permanent Committee, M. Schoder wished to replace the number 7 by 5. Meanwhile a proposal of Mr. Scott in this sense was declined, and then the proposal of the sub-committee was adopted.

Appointment of Permanent Committee.

In respect to the next paragraph of the report, which gives the committee the right of completing itself and adding to its number, Mr. SCOTT raised objections to an unlimited increase. THE REPORTER, however, pointed out that by an increase of numbers the possibility was given for France to take part in it, and M. Bruhns' proposal was adopted, to read the sentence in question in the following words: "The committee has the power "to fill up the places of members who resign, and eventually "to increase itself by the co-option of two members at most."

To the next portion of the Report, M. QUETELET made the proposal that the choice of the President should be left to the committee, but this proposal was not adopted. The proposal of the sub-committee was accordingly accepted, leaving the direct choice of the President of the Permanent Committee to the present Congress.

The Congress then proceeded to the election of the seven members of the Permanent Committee and of its President.

The election took place by voting papers, and the members of the committee chosen were MM. Bruhns, Buys Ballot, Cantoni,

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8th Meeting. Appointment of Permanent Committee.

Jelinek, Mohn, Scott, Wild. The meeting chose M. Buys Ballot as President.

The following proposal of M. Neumayer was then adopted: "The Congress revokes its former decision that the question "of the establishment of an International Meteorological In- "stitution should be entrusted to a committee, consisting of five "members, and hands over the functions to be entrusted to "that committee, to the committee which has just been chosen."

The discussion on the proposals of the 7th sub-committee, with respect to the completion and extension of the existing system of Meteorological stations was postponed.

Synchronous observations, p. 56.

The next matter was the discussion of the proposal of Brigadier-General A. Myer (introduction of simultaneous observations over the whole Northern Hemisphere, 1st Appendix to Protocol of the seventh meeting). GENERAL MYER stated that he was commissioned by the War Department of the United States of North America, to bring before the knowledge of the Congress the deep interest with which that department regarded everything which had reference to the progress of the system of Storm Warnings, and its wish that an exchange of International Telegraphic Weather Reports should be extended as far as possible. Passing on to his proposal, General Myer thought that an actual argument for it was unnecessary, because the importance of simultaneous observations would be generally admitted without any question.

The proposal was approved by many members. M. HOFFMEYER remarked that he could only adopt the proposal if no very great practical difficulties were met with, because the scientific results might not be commensurate with *very* great sacrifices.

M. BUYS BALLOT drew attention to his "Suggestions" in which he had cited simultaneous meteorological observations as an object to be attained.

GENERAL MYER remarked again that his proposal only went so far as to say that the Congress should declare the institution of simultaneous observations over the whole earth as *desirable*, and it was adopted unanimously.

Thermometers and Hygrometers, p. 56.

The discussion of the Report of the 1st Sub-committee (Questions 2—6, respecting Thermometers and Hygrometers, M. Plantamour, Reporter, see 3rd Appendix to Protocol, No. VII.) then came on, and the proposals of the sub-committee regarding Questions 2 and 3 of the Programme were adopted simply.

Radiation.

In regard to Question 4 (Radiation), Mr. BUCHAN recommended that to the Report of the sub-committee a few words of recognition should be added for Messrs. Symons and Stow, who, of their own accord and at their own expense, had instituted extensive series of observations, and had deduced valuable results therefrom. Mr. Buchan's proposal was adopted.

Earth Temperature.

Question 5 (Temperature of the Soil). M. LORENZ proposed that the following words should be added to the Report of the sub-committee: "In order to carry the enquiry further it is recommended that classes of rocks and soils should be sought for

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which behave similarly with regard to the propagation of heat within them. In order to obtain more special details on this question, it must be specially recommended to the notice of the experimental stations for Agriculture and Forestry." A wish expressed by M. Sohncke was also to be introduced, that the latest complete work of M. Dorn on the observation of Earth Temperature should be mentioned, with recognition, in the Report of the sub-committee. 8th Meeting. Earth Temperatures, p. 58.

As to the depths for observations of temperature of the soil, Mr. BUCHAN held three inches as the most important for meteorological purposes, and further expressed his preference for fixed thermometers at all depths not exceeding 24 inches, while M. WILD, especially with regard to the investigations of Frölich and in the interest of pure Meteorology, considered much greater depths necessary for observations of the temperature of the soil. In other respects the Congress adopted the report of the sub-committee on Question 5.

Question 6 (determination of Humidity), M. NEUMAYER recommended, as he had formerly done at the Leipzig meeting, Regnault's hygrometer with an aspirator; M. WILD the Hair-Hygrometer. Mr. BUCHAN considered that the institution of determinations of vapour with Regnault's Hygrometer in connexion with August's Psychrometer and in dry hot climates, was urgently desirable. Upon this the Report of the sub-committee was adopted. Humidity. p. 58.

The Report of the 8th sub-committee (organization of a system of meteorological observations on the Chinese coasts, Appendix 2 to Protocol No. VIII.) was read by Mr. Scott. China, p. 59.

It was resolved to proceed to the discussion of it.

Mr. CAMPBELL thanked the Congress for the general principles of organization recommended by the committee. He held it his duty to observe that the English scale could scarcely be avoided, as it was the one most generally known to seafaring men and to lighthouse keepers, or other officers who would be employed at the stations. The observations, he feared, would be of little *practical* value to navigation unless the readings were, in the first instance, in the English scale. They could be afterwards reduced to the metric scale for Russian and any other stations that wished it, and both scales might perhaps be given in the printed periodical returns for purposes of scientific analysis. Mr. SCOTT declared himself to be fully satisfied with Mr. Campbell's explanation.* General MYER also held that in America, for practical objects, such as Storm Warnings, the English scale was the only one possible. He stated that he was ready to adopt, for international exchange, any scale which was recommended by the Congress. M. NEUMAYER then stated that in the opinion of M. v. Richthofen the whole plan and the choice of stations for China was a good one, and the report of the sub-committee was adopted.

* This, the correct version of Mr. Campbell's remarks, appears as a correction in the German edition.

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8th Meeting. The next meeting was fixed for Monday the 15th September at 10 a.m.

Agenda :—

1. Official communications.
2. Consideration of the form of publications.
3. Consideration of the remainder of the proposals of the 7th sub-committee, (carrying out the Decisions of the Congress and International Institution).
4. Consideration of the questions not yet discussed.

Close of the sitting at 2 p.m.

Verified at the meeting of the 15th September by the Chairman.

C. BRUHNS.

9th Meeting. **Protocol of the Ninth Meeting, 15th September 10.30 a.m.**

PRESENT :

Delegates :—MM. Bruhns, Buchan, Buys Ballot, Campbell, Cantoni, Coumbary, Czelechowsky, Dörgens, Donati, Ebermayer, Fradesso, Gloesener, Hann, Hoffmeyer, Jelinek, Lorenz, Mohn, Müller, Myer, Neumayer, Plantamour, Quetelet, Rubenson, Schenzl, Schoder, Scott, Sohncke, Wild, Winnecke.

Visitors :—MM. Köppen, Nordenskiöld, Ricco, and Wrangel.

Chairman :—M. Bruhns.

The CHAIRMAN opened the meeting at 10.30 a.m.

The Protocol was read and confirmed.

Attitude of the United States towards the Congress. GENERAL MYER requested permission to give the following explanation: The United States have not been prepared to go into a Congress of this description except for expressions of opinion. They could not do so with justice, being the only Government where Weather Report and Signal system is militarily organized, and they could not ask from others what it was not in their power to give. It has been for this reason I have withheld myself from voting upon questions which have arisen, and from other action than advising in particular cases. My duties here are to advance in every way the widest extension of systems of Storm Warning and Weather Report, and my presence is to exhibit the good will of my Government to the Congress and the community of meteorological interests it represents.

Publications. The meeting proceeded to discuss Question 26. (Publications. Protocol of the seventh general meeting).

After a long discussion on the question the following proposals were made relating to it.:—

By M. WILD : The Congress recommends that the publication of comprehensive observations by Central Institutes, and Stations of the First Order, should be entirely separated from the publication of the homologous observations of Stations of the Second Order in each country.

The proposal was adopted.

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M. WILD further made the proposal: Each director shall choose a number of stations in his district and for them shall adopt a uniform plan, which is to be recommended by the Congress, (within the limits which are laid down by the hours of observation). 9th Meeting. Publications.

To this M. BUYS BALLOT made the following additional proposal: This proposal of M. Wild's should only be adopted in view of an international publication.

On the other hand M. PLANTAMOUR proposed: With regard to the publication of observations a distinction must be drawn between those which should refer to the special study of the climate of each country and those which are intended to indicate the simultaneous condition of the atmosphere over the whole of the surface of the earth. For the former it is left entirely free to each country to adopt the form and manner of its publication according to its requirements and resources. For the latter the Permanent Committee shall make proposals with reference to the indication of the stations, and of the data which are required to attain the object, and which shall be furnished in the same form.

Similarly the committee is empowered to make all proposals with respect to the publications.

In a division by name on these two proposals, the first received 10 and the second 8 votes, while 11 of the delegates took no part in the division.

Mr. SCOTT proposed that the best form of publication for the stations selected for international objects should be determined by the Permanent Committee, in consultation with the directors of the central institutes, and that it should be recommended for general adoption, for which object the scheme proposed by Dr. Köppen should be handed over to the committee.

This proposal was adopted.

The only remaining business was the reading of the reports which the sub-committee 6 (Questions 23, 24, 25, Organization, see Appendix 1. to the Protocol of the meeting), and 5 (Questions 22, Maritime Meteorology, and 21, Weather Telegrams, see Appendices 2. and 3.), had completed, and the first was read by M. Wild; the second, in regard to Maritime Meteorology, by Mr. Scott, and respecting Weather Telegrams and Storm Warnings by M. Neumayer.

The next meeting was fixed for 4h. p.m. this day.

Agenda:—

1. Official communications.
2. Discussion of the reports of Sub-committees 7, 6, and 3.
3. Discussion of the proposals of MM. Jelinek and Buys Ballot.

Verified at the afternoon meeting of the 15th September by the Chairman.

BUYS BALLOT.

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10th Meeting.

Protocol of the Tenth Meeting, 15th September, 4.30 p.m.

PRESENT:

Delegates:—MM. Bruhns, Buchan, Buys Ballot, Cantoni, Czelechowsky, Dörgens, Donati, Ebermayer, Gloesener, Hann, Hoffmeyer, Jelinek, Mohn, Müller, Myer, Neumayer, Plantamour, Quetelet, Rubenson, Schenzl, Schoder, Scott, Sohncke, Wild, Winnecke.

Visitors:—MM. Köppen, Nordenskiöld, Wrangel.

Chairman.—M. Buys Ballot.

The meeting was opened at 4.30 p.m., and the Protocol of the previous meeting was read and confirmed, whereupon M. HOFFMEYER read the conclusion of the Report respecting the completion and extension of the existing system of meteorological stations (Appendix 1. to the Protocol of the eighth meeting).

Extension of Meteorological Observations, p. 59.

After a short discussion all the matters in the Report and the suggested addition of M. Neumayer to paragraph γ, "also in "higher southern latitudes," were adopted. By the adoption of paragraphs α and β of the Report, the proposal made by M. Wild, at the sixth meeting (Appendix 3. to that Protocol) is set at rest.

p. 55.

Organization, p. 61.

M. WILD then reported for the 6th Sub-committee on Questions 23, 24, and 25 (Organization, Inspection, and the establishment of uniformity of the normal instruments of the various central institutes). The report on the Inspection of the Scottish Society's stations, which Mr. Buchan had furnished, at the request of the Leipzig Conference, is printed in the Supplement.

p. 93.

The proposals of the Reporter (Appendix 1. to Protocol of the ninth meeting) were discussed and adopted.

On point 2, General Myer made the remark that in North America the inspection of the stations took place regularly *twice* a year. On point 5, MM. HOFFMEYER and RUBENSON proposed not to reject the comparison with good travelling barometers. M. HOFFMEYER also wished that the Permanent Committee should be commissioned to inquire how the comparison of all barometers of all the central stations could be carried out. With regard to the Standard Thermometers the meeting similarly adopted the proposal of the sub-committee in connexion with the suggestion of M. Cantoni, as a result of which it was considered to be the business of each central office to prepare a Standard Thermometer for itself on scientific principles.

Barometers.

Standard Thermometers.

At the same time Mr. Scott was requested to convey the thanks of the Congress to the Kew Committee for their readiness to furnish standard thermometers to the individual Central Institutes.

Kew Standards.

Upon this the report of the 5th Sub-committee with regard to Marine Meteorology was read (Appendix 2. to Protocol of the 9th general meeting).

Marine Meteorology, p. 62.

The Report read by Mr. Scott, as Reporter, was generally

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adopted after a brief discussion. With reference, however, to the sub-committee, which should make preparations for summoning a Maritime Meteorological Conference, MM. DONATI and HOFFMEYER proposed to entrust this matter to the Permanent Committee. This modification of the report of the sub-committee was adopted unanimously. 10th Meeting. Maritime Conference.

Agenda for the next meeting fixed for Tuesday, 16th September at 9h. a.m.:—

1. Official communications.
2. Discussion of the Report of the 5th Sub-committee (Weather Telegraphy).
3. Consideration of MM. Jelinek's and Buys Ballot's proposals.

Close of the sitting at 6.50 p.m.

Verified at the meeting of the 16th September by the Chairman.

C. JELINEK.

Protocol of the Eleventh Meeting, 16th September, 9.30 a.m. 11th Meeting.

PRESENT:

Delegates:—MM. Bruhns, Buchan, Buys Ballot, Cantoni, Coumbary, Czelechowsky, Dörgens, Fradesso, Ebermayer, Gloesener, Hann, Hoffmeyer, Jelinek, Müller, Mohn, Myer, Neumayer, Plantamour, Quetelet, Rubenson, Schenzl, Schoder, Scott, Sohncke, Wild, Winnecke.

Visitors:—MM. Köppen, Nordenskiöld, Wrangel.

Chairman:—M. Jelinek.

After the Protocol of the previous meeting had been read and confirmed, the consideration of the Report of the 5th sub-committee on Weather Telegrams and Storm Warnings, (Reporter, M. Neumayer), which was read yesterday, was proceeded with. Weather Telegraphy, p. 63.

Some introductory remarks were made by the Reporter, and the individual proposals of the sub-committee were read, and, for the most part, adopted unanimously.

Question 2, B. M. BRUHNS made the proposal:—The Congress agrees to the proposal of the sub-committee, although it is not perfectly correct theoretically. It is hoped, however, by a reduction to the level of the sea at the time, to obtain a greater uniformity among the different systems.

After a short discussion of this proposal, against which MM. MOHN, SCOTT, BUCHAN, and NEUMAYER expressed themselves, M. BRUHNS withdrew his proposal, declaring that he was satisfied with its being entered on the Protocol of the meeting.

On Question 4 Mr. SCOTT remarked that it would be very desirable to have a uniform system of cyphers for Weather Telegrams.

M. WILD then proposed that the Permanent Committee should be commissioned to propose such a system, and to circulate it

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11th Meeting. Weather Telegraphy, p. 68.

amongst the directors of the Central Institutes. M. BUYS BALLOT agreed as to the substance, and thought that the Permanent Committee should not receive this commission, but that it should be left to the directors to take steps towards uniformity in this respect. On a division, M. Wild's proposal was adopted.

M. HOFFMEYER declared that in the report in question, he missed a remark which he had made. It was resolved to adopt it supplementarily in the report of the committee.

p. 69. Telegraphy with Madeira.

Upon this M. FRADESSO DA SILVEIRA rose to inform the Congress that Portugal would shortly have telegraphic communication with Brazil. The cable between Portugal and Madeira had been already laid, and from the beginning of October in this year the station of Madeira would be able to send daily weather despatches. M. Fradesso handed to the meeting a paper containing the graphical representation of the simultaneous conditions of the weather at Madeira and Lisbon.

THE CHAIRMAN thanked M. Fradesso for his interesting communication.

THE CHAIRMAN on the close of the discussion of the Report communicated the contents of a letter which he had just received from M. Donati, in which that delegate explained that he had been obliged to leave Vienna on that morning, and regretted that he could not be present at to-day's meeting.

International Fund, p. 48.

In the discussion which next followed, on M. Buys Ballot's proposal at the third meeting, in regard to the formation of an International Fund for the establishment of Meteorological Observatories on islands and at distant points of the earth's surface (Appendix 4 to the Protocol of the third meeting), the Congress decided to leave the further carrying out of the question to the Permanent Committee. M. CANTONI, as well as M. FRADESSO, placed it on record that their Governments were not indisposed to take part in forming an international fund.

The 2nd proposal of M. Buys Ballot respecting the establishment of special offices for the exchange of Meteorological publications had already received a satisfactory solution at the second meeting on the 12th September.

Reports on the state of Meteorology, pp. 47, 48.

With respect to both the proposals of M. Jelinek, in regard to obtaining reports on the organization of the different institutes and systems of observation, as well as in regard to giving information of the series of observations, for a considerable number of years, which exist in each land, the Congress entirely approved of them and decided for M. Hoffmeyer's proposal to hand over to the Permanent Committee the carrying out of both proposals.

Mr. BUCHAN declared it desirable that an accurate Catalogue of all meteorological publications should be prepared.

Thanks to the Austrian Government and the Academy of Vienna.

When the Agenda had been completed Mr. SCOTT proposed to express thanks to the Austrian Government and the Imperial Academy of Sciences for the support which had been given to the Congress in its proceedings.

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M. JELINEK thanked the delegates in the name of the Bureau.

M. CANTONI thanked the Vice-Presidents who had been entrusted with the management of the proceedings of the Congress, viz.: MM. Bruhns, Buys Ballot, Jelinek, Scott, and Wild.

Finally the Congress expressed their thanks, on the proposal of M. Hoffmeyer, to the Committee, appointed by the Leipzig Conference, which had investigated the questions of such extreme importance for practical meteorology, viz.: Weather Telegrams and Maritime Observations, and specially recognised the untiring zeal of the Reporter, M. Neumayer.

In conclusion the thanks of the Congress were expressed to the Secretaries.

Termination of the sitting at 12.15 p.m., upon which the Meteorological Congress of Vienna was declared to be closed, after the Protocol had been confirmed by the Chairman at the meeting itself.

C. JELINEK.

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App., II. 1.

Appendix 1. to the Protocol of the Second Meeting.

ADOPTED BYELAWS.

Byelaws for the International Meteorological Congress, Vienna, 1873.

§ 1.

Byelaws, p. 9. The Permanent Committee elected at the Meteorological Conference of Leipzig shall open the first meeting of the Congress, and shall superintend the election of the Bureau, consisting of the Honorary President, Vice-Presidents, and Secretaries. In the elections in question, the absolute majority decides.

§ 2.

The Permanent Committee shall present a Report on the constitution of the Congress, and submit the communications and papers which have been received since the meeting at Leipzig.

§ 3.

The Permanent Committee shall submit a Programme of the questions to be discussed, and this programme shall be discussed and finally decided at the second meeting.

Each member of the Congress has the right to submit proposals in regard of new subjects to be brought forward for consideration, but such proposals cannot come on for discussion until one of the subsequent meetings.

Proposals emanating from non-members must be supported by members if they are to be brought forward for discussion.

§ 4.

The Congress shall hold its general meetings between the hours of 10 a.m. and 1 p.m. The days of meeting to be fixed by the Bureau.

§ 5.

The Agenda for the general meeting for each day shall be fixed by the Vice-Presidents, and announced, if possible, at the close of the previous meeting, but at latest at the opening of the meeting in question.

§ 6.

In Divisions at the general meetings the absolute majority of the delegates present shall, as a rule, decide. In case of equality, the vote of the Vice-President who is in the chair shall decide.

It is, however, open to any delegate to demand a division according to countries. In case of such a division, the delegates of one and the same country have, after a previous consultation, only one vote to give, which for countries of less than 10 million inhabitants is counted as *single*, for countries of between 10 and 30 million inhabitants as *double*, for countries of over 30 million inhabitants as *threefold*.

§ 7.

For individual points of the Programme Sub-committees shall be appointed, the members of which shall be selected by the Bureau and nominated by the Congress.

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§ 8.

The editorship of the Proceedings of the Congress shall be entrusted to a special committee, which shall make provision for the printing and distribution of the Protocols. App., II. 1. Byelaws, p. 9.

(Adopted at the Second Meeting of the Congress.)

Appendix 2. to the Protocol of the Second Meeting. App., II. 2.

PROGRAMME of the PROCEEDINGS of the METEOROLOGICAL CONGRESS at VIENNA, 1873.

I. INSTRUMENTAL.

1. What is the best form of Barometers for stations of the second order? p. 20.
   Is the use of Aneroids for such stations admissible?
2. What mode of exposure of Thermometers for the observation of Air Temperature is the best and most suitable for general adoption?
3. What is the best construction of Maximum and Minimum Thermometers?
4. What instruments should be employed for determining the intensity of Radiation, and in what way can the comparability of the results obtained be ensured? pp. 32, 56, and 77.
5. What apparatus is the best for determining Earth Temperatures?
   At what depths should the observations be taken in order to attain the uniformity which is desirable?
6. What apparatus should be employed for the determination of the Hygrometric condition of the air? pp. 33 and 58.
   Are the Wet and Dry Bulb Thermometers sufficient?
   Can the Hair Hygrometer be employed, and under what restrictions?
7. In what way can uniformity in describing the Directions of the Wind be attained?
   Is the deduction of the mean Direction of the Wind by Lambert's formula desirable?
   Is it desirable or not to include very light winds (force 0) in constructing Wind Roses for the Direction of the Wind? pp. 25 and 51.
8. What scale should be employed for the Force of the Wind when it is determined, not by actual measurement, but only by estimation?
9. Is it desirable to introduce simple dial instruments for determining the Velocity of the Wind? p. 91.
   What units should be taken for the discussion of the Velocity of the Wind?
10. What is the best form, size, and mode of exposure of Rain Gauges?
    At what hour of the day should the fall be measured? pp. 27, 52, and 86.
11. Should the days of Rain and Snow be counted separately or together?
12. Is it desirable in giving the falls of Hail to draw a distinction between "Graupel" and true Hail?
13. *a.* In counting Thunderstorms, should the Storms, as such, or the Days of storm be given? pp. 14 and 48.
    b. In what way should the instances of Sheet-lightning be noticed?
14. What apparatus is to be recommended for the measurement of Evaporation? pp. 29 and 53.
    What is the most suitable exposure for the Evaporation gauge?
15. *a.* In what way should the proportion of Cloud in the sky be estimated and indicated? pp. 15 and 49.
    Is it desirable to introduce for Clouds, Hydrometeors, and for other extraordinary phenomena, symbols which shall be independent of local language, and therefore universally intelligible? pp. 19, 29, 45, and 48.
16. Should other Meteorological Elements than those already enumerated, *e.g.*, Atmospheric Electricity, Ozone, &c., be included in the scope of normal observations, and what are the best instruments for observing them? pp. 16 and 45.

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App., II. 2. pp. 21 and 49. 17. Is it desirable to introduce the same Units of Measure (viz. of Length, Degrees, and Time) in meteorological inquiries in all countries, or is it sufficient to lay down certain fixed rules for the conversion of the different measures employed in the several countries?

II. Institution and Reduction of the Observations.

pp. 29 and 52. 18. Can uniform Hours of Observation be introduced for the general observations to be made at the Meteorological Stations?

p. 23. 19. What are the rules and what the intervals of time for which the Means of the several Meteorological Elements should be calculated?
Which is the better plan, to begin the meteorological year with January or with December?

p. 24. 20. In what manner and for what intervals are the Normal Values for the individual Meteorological Elements to be deduced?

III. Weather Telegrams.

pp. 37 and 63. 21. Does the interchange of Weather Telegrams appear so useful that it should receive a fuller development and a firmer organisation?

IV. Maritime Meteorology.

pp. 36 and 62. 22. In what way can Maritime Meteorology be best introduced into the system of General Meteorology?

V. Organization.

pp. 36, 61, and 93.
23. Is it desirable that in each country there should be established one or more Central Institutions for the direction, collection, and publication of the Meteorological Observations?
24. Can rules universally applicable be laid down for the Verification of Instruments and the Inspection of Meteorological Stations?
And is it advisable to introduce general Instructions for taking and calculating Meteorological Observations?
25. In what manner can the agreement of the Standard Instruments of the different Central Establishments be best effected?

VI. Publication of the Observations.

p. 34. 26. Is it desirable and possible to publish the Meteorological Observations of a limited number of stations in each country in a uniform manner, and within a reasonably short time after the observations have been made?

pp. 30, 48, and 56. 27. How is the exchange of the Meteorological Publications of different institutions and different countries to be carried out most speedily, safely, and simply?

VII. Carrying out the Decisions of the Congress.

pp. 31 and 59.
28. What regulations should be adopted in order to carry into effect the decisions and the views of the Meteorological Congress?
Is the appointment of a Permanent Committee and the organization of future Meteorological Congresses requisite for this purpose?

pp. 27, 50, and 71. 29. M. Plantamour's proposal respecting the foundation of an International Central Institute for Meteorology?

Appendix 1. to the Protocol of the Third Meeting.

Report of the Leipzig Sub-Committee (Ebermayer, Schoder, Sohncke), on Questions 12, 13, 15, 16, of the Programme of the Congress.

p. 14. Question 12. Is it desirable in giving the falls of Hail to draw a distinction between "Graupel" and true Hail?

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The separate notation of Hail and "Graupen" assumes that both of the two phenomena are recognizable by distinct characteristics. It is a question whether or not this be the case, in accordance with the general usage of the German language (for *e.g.* no distinction is made in the English language). App., III. 1. Hail.

1. "Graupeln": roundish, whitish, loosely-aggregated masses of frozen water, sometimes of the size of peas, and resembling small balls of snow.

2. Hail: larger pieces of harder and denser ice, of a less spherical form, flatter disc shaped or of the shape of a truncated cone.

If the size be considerable, alternate coats of clear, and of opaque white, ice are recognizable, enveloping a nucleus of the nature of "Graupel," at times studded at the outer surface with large crystals of ice. It is easy to distinguish between these extreme cases, but with intermediate types, it is optional whether they should be described as Hail or "Graupel," and for such another special term "Schlossen" is employed.

It is quite inadmissible to avoid the difficulty of drawing the distinction, by the attempt which has been made to take into consideration the distinct origin of each phenomenon, as there are as yet nothing beyond hypotheses to account for their origin. If therefore the two phenomena cannot be distinguished from each other *with absolute certainty*, it is neither scientifically justifiable, nor practically possible, to record them separately.

Agriculture has certainly a real interest in drawing the distinction, but for this it is certain that the records of Hail Insurance Companies furnish better materials than Meteorological Journals.

As a result of these considerations the committee recommends that there shall be only *one* column for "Hail", and that falls of "Graupel," but only such as are *absolutely indisputable*, should be indicated by a small star, inserted close to the entry, or by a symbol differing slightly from that for Hail. This will render it possible, besides counting the falls indiscriminately, to pick out the one exceptional case. Furthermore it is desirable that in the column "Remarks" more special details should be given of the entire phenomenon, size of stones, direction of motion and superficial extent of the hailstorm, existence or the contrary of thunderstorms, damage done, &c.*

Question 13.

(*a.*) In counting Thunderstorms, should the Storms as such or the Days of Storm be given? p. 14.

(*b.*) In what way should the instances of Sheet-lightning be noticed?

(*a.*) It is of course inadmissible for a single observer to speak of several storms prevailing at the same time (as is often popularly done), inasmuch as, at most, two distinct clouds are present and influencing each other. Accordingly the enumerations of several storms for one and the same day, can only refer to storms distinctly separated from each other *as to time*. It is however often difficult to decide if two thunderstorms occurring successively are independent of each other, or if the one is only to be regarded as the continuation of the other, so that it would be a matter of *choice* for the observer whether he recorded two storms or one. It is recommended *only to count the days of storm in order to obtain more easily comparable figures.*

This is not meant to preclude the individual observer from recording in his "Remarks" the number of Storms, the time of their commencement, their duration, direction of their motion, &c.†

(*b.*) It must first be settled what phenomenon is to be described as *sheet-lightning*. Some authors extend this description to the ordinary flashes of lightning without audible thunder. This use of the word is however scarcely justifiable. It is very improbable that a discharge of that nature is unaccompanied by sound at the place of its occurrence, inasmuch as the electrical sparks in laboratories are always accompanied by sound. On the other hand the non- p. 14.

* The definition adopted at the Third Meeting (p. 14) was as follows:—"Hail is to be "described as a precipitation of frozen water, in which the stones attain such a magnitude that "they may be expected to do damage to agricultural products."

† Adopted at the Third Meeting (p. 14).

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App., III. 1. Sheet-lightning.

occurrence of thunder in such instances of lightning, which is in other respects quite normal, is easily explained by the operation of different causes, which perhaps often act in common; they are as follows: 1. Great distance. 2. Discharge in very rarified air (at a great height), so that the *vis viva* of the mass originally set in motion is too small to be able finally to affect appreciably the ear of the observer when it has been translated to greater and greater strata of denser masses. 3. Repeated reflections at the limits of strata of air and clouds of unequal density, whereby the sound transmitted is weakened at every time. It seems therefore better to follow the authors who exclude flashes without thunder from the category of sheet-lightning, and then we have this definition.

p. 14.

> Sheet-lightning is a sudden expansive illumination, unaccompanied by any noticeable thunder, which is observed in the clouds, and also in the clear sky, mostly in the neighbourhood of the horizon.

It hardly admits of a doubt that the phenomenon so defined is attributable in various cases to two or more agencies. Firstly, the reflection of distant flashes which either take place below the horizon, or are themselves invisible owing to the thickness of the intervening clouds, will appear as sheet-lightning. (Arago, in his essay on Thunderstorms, cites the fact that in the year 1803 luminous signals which were made on the Brocken by less than half a pound of powder were noticed at a distance of more than 120 miles, when the Brocken was no longer visible owing to the curvature of the earth.) Secondly, weak surface discharges (Flächenblitze) with slight noise (which according to Kundt's observations give the same lines in the spectrum that Schimkov observed in the *faint-glow* and brush discharges of the electrical machine, and which must accordingly be regarded as such discharges from the clouds) produce the phenomenon of sheet lightning.

The sub-committee is unanimous that on the whole, in the case of the co-existence of a thunderstorm at any time, sheet-lightning should not be specially noted, because in every storm inaudible discharges of one or the other origin will occur. Specially remarkable cases of sheet-lightning ought to be recorded by the observer in the "Remarks."

The opinions of the sub-committee are divided as to the mode of recording sheet-lightning on a day when there was no *actual* thunderstorm. The majority are against counting a day on which only sheet-lightning had been observed among the days of thunderstorm. The minority think that by such a practice many storms which took place below the horizon would be neglected, and that no other limits than those of *visibility* could be laid down for the area of observation of any given station, so that accordingly days with sheet-lightning should be counted with days of thunderstorm; they might, however, be distinguished from the others by a star or other mark.*

Question 15.

p. 15.

> *a*. In what way should the proportion of Cloud in the sky be estimated and indicated?

pp. 19, 29, and 48.

> *b*. Is it desirable to introduce for Clouds, Hydrometeors, and for other extraordinary phenomena, symbols which shall be independent of local language, and therefore universally intelligible?

The first part (*a*) of Question 15 has been already settled at the Leipzig Conference, inasmuch as it was agreed that the amount of Cloud should be estimated from 0 to 10, 0 indicating a perfectly cloudless, 10 an entirely overcast sky.

As to the second question, the following Table gives the designations which have been hitherto employed.

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* The definition adopted at the Third Meeting (p. 14) was as follows:—"As days of storm, "only those are to be noted on which both lightning and thunder have been observed. If only "lightning without thunder has been noticed, the entry for the day must be sheet-lightning."

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These for the most part consist of the initial letters of the respective words, and are therefore dependent on the individual language.

App., III. 1. Symbols, pp. 29 and 48.

—	Rain.	Snow.	Rain with Snow.	Thunder-storm.	Lightning.	Thunder.	Hail.	"Graupel."	Mist (Fog).	Hoar frost.	Dew.
Prussia and Saxony.	R	Sch	R,Sch	G	Bl	D	H	Gr	N	Rf	Th
Baden - -	R	S	—	—	—	—	—	—	—	—	—
Bavaria - -	R	S	—	—	—	—	—	—	N	Rf	—
Würtemberg -	Rg, rg	Schn, schn	—	Gew	—	—	Hgl, hgl	Grp	Nb, nb	R	Th, th
Austria - -	‖	✳	—	↕	↑	—	△	—	●	—	—
Switzerland -	R	S	—	G	—	—	H	Gr	N	Rf	Th
France - -	●	✳	—	—	—	—	▣	□	○	△	∴
Italy - -	pl	nv	—	—	l	t	gr	—	nb	br	rg
Holland - -	R, r	Sn, sn	—	—	⊕ with ○ without	Thunder	Ha, ha	—	⊙	—	—
England - -	r, r, r	s, s, s	—	—	l	t	h	—	m	—	w
Denmark and Sweden.	R, r	S, s	Sl	—	Z	Td	H, h	—	T, t	—	—
Russia before 1870.	pl	Ng	—	—	E	T	gr	—	Br	gbl	—
Russia since 1870.	●	✳	●✳	⌐≷	≷	T	▣	□	○	⁂	8
United States -	Ⓡ	Ⓢ	—	—	—	—	—	—	—	—	—

The Sub-Committee proposes the following Symbols:—

Rain - - - - ●
Snow - - - - ✳
Thunderstorm - - ⌐≷
Hail - - - - ▲
"Graupel" - - - △
Mist (Fog) - - - ≋
Hoar frost - - - ⌴
Dew - - - - ⊃

The Sub-Committee furthermore recommends, that if in any publication additional Abbreviations or Symbols are employed, the explanation of them should be given in some prominent place, and in several languages, not in the individual language only.

Question 16.

In respect of Atmospheric Electricity the questions are,

p. 16.

(*a.*) Should Atmospheric Electricity be included in the list of normal observations?

(*b.*) What are the best instruments for observing it?

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App., III. 1. Atmospheric Electricity, p. 16.

(*a.*) Atmospheric Electricity is at the present time one of the phenomena of terrestrial physics which is least understood, therefore its enrolment among the normal objects of observation is at the least as great a want (for theory, though not as yet for practice) as the observation of the other elements; but, in consideration of the difficulty and delicacy of such a class of observation and of the fact that ordinary observers should not be overloaded with too many different observations, *the observation of Atmospheric Electricity can be recommended only for Head Observatories.**

(*b.*) In treating of instruments for the observation of Atmospheric Electricity the *measuring* apparatus must be considered separately from the *collecting* apparatus.

A. *Measuring Apparatus.*

The most sensitive and accurate Electrometer, on the whole, is Thomson's Divided Ring Electrometer with mirror and light. This may also be employed for the measurement of atmospheric electricity (for which purpose it was specially invented). None of the other electrometers, whether they be instruments on the principle of the Torsion Balance, or on that of the gold leaf electroscope, are equal to Thomson's. In using it, however, special attention must be paid to one point. Inasmuch as the needle on which the quadrants, charged with atmospheric electricity, act, is itself kept in an electrical condition by a Leyden jar placed within the apparatus, the extent of its deviation depends upon the charge of the jar. It is therefore important to keep the charge of the latter constant. This is rendered possible by the fact that a charging apparatus ("replenisher"), constructed on the principle of Holtz's electrical machine, and a gauge are attached to the jar. By means of the gauge a knowledge of the condition of the charge is obtained, and by means of the "replenisher" the loss is easily replaced. With good instruments the charge does not decrease more than 1 %, at most, within 24 hours, thus it is enough to complete the charge twice or thrice a day to keep it as good as constant. The same end might be attained in a simpler, if not in altogether as certain a way, by regulating the charge so that the electromotive force of a Daniell's cell should always produce the same deflection of the needle.

B. *Collecting Apparatus.*

The water collector proposed by Thomson works best. It is an insulated metallic vessel containing water, standing in a room, with a long pipe reaching outside the window, from which the water runs in a fine stream. Instead of this in winter a burning match of paper, soaked with nitrate of lead, is used; an insulated wire connects the collector with the divided ring of the electrometer. *Ceteris paribus* the instrument charges itself equally by both kinds of collecting apparatus; the deflection of the needle measures the difference of the potentials, *i.e.* of the electrical tension of the air at the place where the stream is dispersed, and the potential of the earth.

The advantages of this collecting apparatus over all others, be they fixed rods with points, or metallic bodies projected to a height, connected during a short part of their flight with an electrometer at rest, are the following:—

1. Simplicity of manipulation (you only turn the water-cock).
2. Strong and rapid collecting action. In a few seconds the maximum of charge is attained, while a fixed pointed collecting rod requires about a quarter of an hour.
3. Good insulation, as the apparatus stands in a room.

Owing to the almost instantaneous indication of the intensity of atmospheric electricity, Thomsons's complete apparatus is also especially adapted for *continuous registration*, if the reflected image of the light be allowed to play on a strip of photographic paper passing slowly under it.

In order to make different observations comparable two things are requisite:—

1. The indications of different instruments must be referred to each other. This is done by comparing their behaviour when the same source of electricity is employed, *e.g.* the electromotive force of a Daniell's cell.

* It was resolved at the Third Meeting (p. 16), "That the institution of observations on "Atmospheric Electricity be recommended only for Head Observatories, and that the decision, "as to the choice of the best methods of observation and of the most suitable instruments, must "be left to them."

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2. Inasmuch as the deviation of the needle measures the difference between the tension at the point of dissipation of the stream of water and that in the earth, the observations of all stations must be reduced to the same height of point of dissipation above the ground, for *atmospheric electricity increases with height*. For this purpose the indication of the instrument at the station must be compared with the simultaneous indication of another instrument, erected at the normal height above the ground, in an open level place in the neighbourhood, the action of the latter instrument having previously been compared with that of the instrument at the station.

In this way all the results from all stations may be reduced to the same normal height, and may thus be rendered really comparable with each other.

App., III. 1. Atmospheric Electricity, p. 16.

Among the meteorological elements which must be considered in addition to atmospheric electricity, the next are Ozone measurements, which increase in importance the more we are convinced of the importance of the ozone in the atmosphere. Unfortunately Schönbein's ozonometers, which have been employed for this purpose, are insufficient, and leave much to be desired in regard of their sensitiveness and accuracy. The Iodide of Potassium and Starch papers recently prepared by Kroll & Co. at Berlin are somewhat more sensitive, but on the other hand the ozone scale prepared by Kroll & Co., with 16 different grades, cannot be recommended, inasmuch as the last four numbers do not permit of any detection of difference in regard to the intensity of colour. A scale of 10 or 12 degrees appears to be the most suitable, but the colours must correspond better with the real conditions than is the case with Schönbein's scale.

Ozone, p. 16.

The measurements themselves should be made every 12 hours, and in the choice of the respective localities, the vicinity of sewers, dung-hills, open drains, in short everything which can cause a de-ozonization of the air should be avoided. Neither sun-light nor rain should have access to the ozone papers.*

There are a series of other subjects which require regular observation, as *e.g.*, measurements of water in the soil, determination of the amount of water soaking through the soil, determination of the carbonic acid and vapour contained in the air in the soil, &c., &c. But these matters fall outside the domain of Meteorology, and the carrying out of these observations must be left to such departments as have a special interest in them.

Prof. Dr. Ebermayer, Aschaffenburg.
Prof. Dr. Schoder, Stuttgart.
Prof. Dr. Sohncke, Carlsruhe.

July 1873.

Appendix 2. to the Protocol of the Third Meeting.

App., III. 2.

The Congress should take into consideration whether it would not be well to request the heads of the various systems of Meteorological observation to furnish reports, of as uniform a character as is possible, on the organization of their systems of observations, and especially of their Central Institution (if there be one) and on the condition of Meteorological investigations and publications, as well as on desirable developments and improvements. These reports should be collected and printed in a publication to be selected by the Congress.†

Reports on organisation, p. 38.

C. Jelinek.

Appendix 3. to the Protocol of the Third Meeting.

App., III. 3.

The Congress should take into consideration whether it would not be well in the interest of facilitating meteorological investigations to request the heads of the various systems of observation to state how many long-continued series

Existing series of observations, p. 38.

* It was resolved at the Third Meeting (p. 17), that "The present methods of determining "the amount of Ozone in the air are insufficient, and the Congress therefore recommends "experiments for the discovery of better methods."
† Adopted at the Eleventh Meeting (p. 38).

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App., III. 3. Existing series of observations, p. 38.

of observations, printed or not, exist in their respective countries. In the case of printed observations the title of the publication (including publishers' name and the price) should be given, and in the case of unprinted ones the mode in which either extracts or copies can be procured. For the most important meteorological elements the mean values should be given, with indication of the years from which they have been deduced.

The contents of these communications should be published by a special committee to be chosen by the Congress, and in a manner to be determined by that committee.*

C. JELINEK.

App., III. 4.

Appendix 4. to the Protocol of the Third Meeting.

International Fund, p. 38.

1. Should we not express the hope that an International Fund should be established, out of which observatories on islands, and at out-lying localities, can be organized and maintained?†

Exchange of publications, p. 30.

2. Is it not desirable, in order to facilitate the exchange of publications, to organize, on the model of the Smithsonian Institute at Washington, and the Central Bureau at Haarlem, a similar office in every country?‡

BUYS BALLOT.

App., IV. 1.

Appendix 1. to the Protocol of the Fourth Meeting.

Symbols, pp. 19, 29, and 44.

REPORT of the SUB-COMMITTEE chosen at LEIPZIG on Question 15, discussed at the Meeting of September 7th; 10 a.m. till 1 p.m.

Present: the Sub-Committee, consisting of—
Ebermayer, President.
Schoder, Reporter.
Sohncke,
and in addition the co-opted members,
Wild, Lorenz, Plantamour.

1. For the designation of the hydrometeors and other phenomena, the following symbols were proposed:

1. The following Symbols are proposed for the indication of Hydrometeors and other phenomena:—

Rain	●	Glazed Frost ("Glatteis")	~
Snow	✳	Snow-drift	⇅
Thunderstorm	↯	Ice crystals	←
Lightning without Thunder, or Sheet Lightning.	↯	Strong wind	⟋
Hail	▲	Solar Corona	⊕
"Graupel"	△	Solar Halo	○
Mist, Fog	≡	Lunar Corona	⋓
Hoar-frost	⌊	Lunar Halo	ψ
Dew	⊥	Rainbow	⌒
§Silver-thaw ("Rauh-frost," "Duft")	V	Aurora	♕
		Dust haze ("Höhen-rauch")	∞

* Adopted at the Eleventh Meeting (p. 38), with the modification, that the carrying out of this and the preceding proposal be entrusted to the Permanent Committee.

† At the Eleventh Meeting (p. 38) it was resolved that the further carrying out of this question should be entrusted to the Permanent Committee.

‡ Adopted at the Seventh Meeting (p. 30).

§ "Rauh-frost" or "Duft-anhang" is the phenomenon of the deposition of a large quantity of frozen moisture on trees when the weather suddenly becomes warm after great cold, sometimes called, as above, "Silver-thaw."

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In respect of their intensity, the individual phenomena are to be distinguished by the figures 0 and 2, which should be used as exponents of the symbols, in such a way that 0 should indicate very slight, 2 strong. App., IV. 1. Symbols, pp. 29, 44.

e.g. $\bullet^0$ slight Rain.
$\bullet^2$ heavy Rain.*

It is further to be remarked that Fog (mist) is only to be entered when the observer is quite enveloped in it. Höhenrauch (dust haze), moreover, is not only to be indicated by the proper symbol, but at the same time the concomitant obscuration of the atmosphere is to be noticed under the head of Amount of Cloud.

Clouds.

1. Entries as to the extension of clouds on the visible sky according to the scale 0–10 are to be made without reference to the thickness of the cloud. The latter is to be indicated by an exponent applied to the figure for the amount of Cloud (0 slight, 2 great). Clouds, p. 15.

2. As to the Forms of Cloud, or rather, classes of cloud, the matters most urgently desired are more thorough observations and more accurate drawings, which will correspond to the variety of clouds which are in reality observed; as all the systems which have as yet been proposed, *e.g.* that of Poëy, are not of such a nature that they can at once be recommended for general adoption.

3. For the present it is recommended to add to Howard's designations and their combinations, epithets as characteristic as possible, according to the choice of the individual observer, in order to express the actual appearance as clearly as possible.

4. In order to facilitate a correct understanding and designation of the clouds, it is recommended,

(*a.*) That Central Offices should prepare as completely as possible lists and characteristics of the forms of cloud which occur in the district.

(*b.*) That on the part of the Congress the preparation of sketches of the principal forms of cloud be set on foot, which should be added to the Instructions for the observers.

(*c.*) That the study of the connexion between the form, constitution, and origin of the clouds be undertaken and supported, special attention being paid to the circumstance that one and the same mass of cloud presents a different appearance when seen from different sides or under different angles.†

Reporter, SCHODER.

Appendix 2. to the Protocol of the Fourth Meeting.

App., IV. 2

Question 17 (Units of Measure).

A resolution was adopted on this question at the Leipzig meeting, to the effect that the results of observation or the means should be published in the Metric (and Centigrade) scales in addition to appearing in the original scales. (See Report of the Conference, p. 12).‡ Units of Measure, p. 21.

At the meeting at Bordeaux the proposal was made (Report, p. 67) to publish in uniform scales the observations of a selection of stations which are of pre-eminent importance for the Science in general, while those stations which are rather intended to serve for the study of the local conditions of climate should for a long time yet content themselves with the various scales in use in the country.

This has been recommended in the same way by W. Köppen in the Journal of the Austrian Meteorological Society (1873, No. 2, p. 19), and agrees with the proposal made there, and also by Prof. Wolf, in his letter to the Swiss Meteorological Commission, to consider in general only a certain minimum of stations as appertaining to the general international scheme of observation,

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* Adopted at the Seventh Meeting (p. 29).
† Adopted at the Fourth Meeting (p. 20).
‡ The references in this Appendix refer to the pages of the English translation of the Report of the Leipzig Conference (Stanford), price 1*s.*

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App., IV. 2. Units of Measure, p. 21.

but that for these the observations and publication should be carried out nearly or entirely in an uniform manner.

In their letters to the Leipzig Committee, M. Fradesso da Silveira (Report, p. 47), Mohn (Report, p. 56), and Wolf (Report, p. 66), express themselves decidedly for the necessity of the general adoption of uniform scales, viz., of Millimètres and Centesimal degrees; while, M. Fritzch (Report, p. 49), and Mr. Symons (Report, p. 65), as well as the French meteorologists, in view of the difficulty of attainment of a general uniformity, recommend the improvement and further consolidation of reduction tables, and Prof. Dove (Report, p. 46), with Mr. Scott (Report, p. 12), raise the question whether, if a general uniformity be attainable, it would not be wiser to attempt this in respect of English inches and Fahrenheit degrees, instead of the millimètres and centigrade degrees which are usually proposed.*

Reporter, WILD.

App., IV. 3.

Appendix 3. to the Protocol of the Fourth Meeting.

REPORT of SUB-COMMITTEE VII. on QUESTION 29 (Foundation of an International Central Institute for Meteorology).

International Institution, pp. 27 and 71.

Questions 28 and 29 were referred to the seventh sub-committee, but that committee thought that it would be best to separate the reports on these two questions, and to bring forward to-day the results at which they had arrived on Question 29, and at a later period to hand in a report on the first question.

In the discussion of the questions which are included under Question 29 the sub-committee has had an advantage, in that several members of the Congress have had the kindness to take part in it, and to give full expression to their opinions on the question.

The Sub-Committee thereby has been placed in a position to gain information as to the more general conception of the meaning of such an international Institute ("Anstalt"), and thereby has obtained a better insight into the various difficulties which the question presents.

From these proceedings it appears to be absolutely unanimously conceded that there is a general want for the establishment of an International Meteorological Institute, to which, as principal duties, should be confided, to collect the necessary data for a comprehensive view of the course of meteorological phenomena over as much of the earth's surface as is possible, and to publish them internationally.

On the other hand it appeared in the discussion which took place that on various grounds it was not considered that the moment had quite arrived, nor was the matter ripe enough to lay before the Congress definite proposals for the immediate establishment of such an Institute.

In consideration of the generally admitted importance of the question for the progress of meteorology, and that it may not be altogether shelved, the sub-committee is perfectly unanimous in proposing to the Congress the following resolutions:

1. The Congress holds the establishment of an International Institute for the advancement of Meteorology as really useful and desirable.†

2. The Congress at once names a special committee of five members with instructions to investigate all the questions bearing on the establishment of this Institute, and to propose a detailed scheme. The committee should publish the result of its inquiry and proposals in the course of the year 1874 and should disseminate them as widely as possible, so that they can be taken into consideration by a future Meteorological Congress.‡

Reporter, HOFFMEYER.

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* The following resolutions were adopted at the Fourth Meeting (p. 21):—

1. For observations as well as for publications the use of the same units of measure is desirable.
2. The Congress expresses its conviction, that among all the existing systems of measure, the Metric has the best prospect of universal adoption.
3. The Congress declares it to be most desirable, if it be not possible to introduce uniform measures at present, to use henceforth only Metric and English measures (with Celsius and Fahrenheit scales).
4. All action is to be supported which tends to the introduction of the uniform Metric system.

† Adopted at the Sixth Meeting (p. 27), with the modification that instead of the expression "Anstalt" (Institute), the expression "Institution" (Institution) should be inserted.

‡ It was further resolved at the Eighth Meeting (p. 32), that the resolution bearing on the appointment of a Special Committee consisting of five members be revoked, and that the functions designed for that Committee should be entrusted to the Permanent Committee.

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Appendix 1. to the Protocol of the Fifth Meeting.

App., V. 1.

REPORT of SUB-COMMITTEE II. on QUESTIONS 7–9 (Wind; Observation and Calculation). Wind, p. 25.

Question 7.

In what way can uniformity in describing the Directions of the Wind be attained?

Is the deduction of the mean Direction of the Wind by Lambert's formula desirable?

Is it desirable, or not, to include very light winds (force 0) in constructing Wind-Roses for the Direction of the Wind?

The Sub-Committee proposes:—

1. To introduce the English designations of the directions of the wind:—N. = North, E. = East, S. = South. W. = West.

2. To give only 16 directions of the wind in the wind rose. In the case of intermediate directions of the wind being observed, it is proposed to count them alternately to the one side or the other.

The Sub-Committee is further of opinion that the application of Lambert's formula is not to be recommended, but on the other hand, that the frequency and mean force of the winds which correspond to the different directions should be given in numbers. In the distribution in the wind-rose those winds whose velocity is less than ½ metre per second (2½ miles per hour) are not to be regarded, but counted as Calms.

The proposal of M. v. Oettingen to reduce the wind, in Direction and Force, immediately, to the four cardinal directions is considered as only suitable for special investigations.

Finally, the Sub-Committee recommends that the direction of the wind in the various strata of clouds (the cloud drift) should be observed and noted.

Question 8.

What scale should be employed for the Force of the Wind when it is determined, not by actual measurement, but only by estimation?

MM. Buys Ballot, Jelinek, and Scott, at the suggestion of the Leipzig Conference have commenced investigations on the comparison and regulation ("Normirung") of scales of Wind Force, but the experiments are not completed.

The Sub-Committee is not in a position to recommend a general scale for the estimation of wind force, but expresses the wish that a gradual advance should be made towards giving the velocity of the wind *in metres per second*.

Question 9.

Is it desirable to introduce simple dial instruments for determining the Velocity of the Wind?

What units should be taken for the discussion of the Velocity of the Wind?

The Sub-Committee recommends that the simple apparatus for measuring the force of the wind, which has been proposed by M. Wild, and is already used in Switzerland, Baden, and Russia, should be introduced as soon as possible at stations of the second order. Wild's Wind-gauge, p. 91.

Furthermore, the Sub-Committee proposes that the velocity of wind obtained by means of anemometers should be expressed *in metres per second*, and recommends the preparation of tables for facilitating the mutual conversion of the velocity of the wind when given in metres per second, kilometres per hour, or English miles per hour.*

Reporter, M. HOFFMEYER.

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* Adopted at the Sixth Meeting (p. 25).

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App., V. 2.

Appendix 2. to the Protocol of the Fifth Meeting.

Rain, pp. 27 and 86.

REPORT of SUB-COMMITTEE III. on QUESTIONS 10 and 11 (Observations of Precipitation).

Question 10.

What is the best form, size, and mode of exposure of Rain-gauges?

At what hour of the day should the fall be measured?

After a thorough discussion the Sub-Committee thinks, with regard to those two questions, that it can propose the following rules of general applicability.

According to the comparative observations carried out in Scotland and England, rain-gauges whose receivers have diameters of only three English inches are said to give results nearly the same (with not more than 2% difference) as such as have larger receivers (up to 24 inches diameter).

The Sub-Committee considers it best to propose for all rain-gauges a circular receiver of one-tenth square metre surface,* and to provide the edge with a strong turned ring of brass formed conically.

In the erection of rain-gauges, care must be taken that the receiver should not be less than one metre (or still better 1½ metre) (from 3 to 4½ feet) above the ground, to admit of the inspection of the receiver and of the easy removal of it. Under all circumstances, in the publication of the results, the distance of the receiver from the ground ought to be given. As to the size of the collector, no general rules can be given, inasmuch as this must be regulated according to the local amount of rain, but under all circumstances the construction of the rain-gauge must be of such a kind that the evaporation of the water collected is prevented as much as possible.

In all cases, where it can be done, the measurement of the amount should take place immediately at the end of the fall; in other cases the first observing hour of the day is recommended. The amount measured in that case is to be put down in the register for the previous day.

In a special column in the register, wherever possible, should be given the duration of the fall, expressed in hours, in addition to the quantity of rain.

Question 11.

Should the days of Rain and Snow be counted separately or together?

The proposal of the Sub-Committee is, that in the register, under the column of "Remarks," the character of the precipitation should be indicated by the symbols adopted by the Congress, and that furthermore, in the monthly *resumé*, the sum of all the days of precipitation should be given and the number of days with snow, hail, and *graupel* should be especially noticed. The days are to be counted as snow-days on which both snow and rain fell.

In the register three columns are to be introduced for precipitation; one for the amount of fall, the second for the depth of snow, and the third for the duration of the fall, expressed in hours.

In the publication of the yearly *resumé* should be further shown—

a. The maximum fall in 24 hours from month to month.

b. The number of days of fall which are below one millimetre (0·04 in.), and the number of those which are below ¼ millimetre (0·01 in.)†

Reporter, M. EBERMAYER.

App., VI. 1.

Appendix 1. to the Protocol of the Sixth Meeting.

REPORT of SUB-COMMITTEE IV. respecting QUESTION 18. (Hours of Observation.)

Hours of observation, p. 29.

The Sub-Committee are not prepared to propose a definite combination of hours for the meteorological observations of all countries, since regard must

* About 14 inches diameter.

† The proposals of the Sub-Committee were adopted at the Sixth Meeting (p. 27), with the modification that the suggestion in *b* should be only recommended.

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be had for the customs of the country; but it would urge that the various hours of observation which should be chosen should give a daily mean of the temperature, which should be as near as possible to the true one; and more particularly, in taking means, that the giving of too great weight to observations taken at a warm part of the day should be avoided. As suitable combinations of hours the Sub-Committee recommends— App., VI. 1. Hours of observation, p. 29.

h.	h.	h.		h.	h.	h.		h.	h.
6	2	10		8	2	8	With minimum temperature.	8	8
7	2	10		9	3	9		9	9
7	1	9		10	4	10		10	10
7	2	9							

As the three last-mentioned observations, twice a day, at equidistant hours, give good daily means of temperature, but do not allow of the recognition of daily variations of temperature, the simultaneous use of maximum and minimum thermometers must be recommended, in addition to these combinations (but with the necessary care which these instruments require).

In each system of observation, investigation should be made, at a sufficient number of normal stations, as to the corrections for the most important meteorological elements (especially Temperature, then Pressure and Humidity) which should be applied to the means of the adopted observations in order to bring them to true 24-hourly means; but monthly means of the observations should be given for the various hours of observation, and it seems furthermore desirable, when it is considered that such means may be directly used, to give the monthly means of Temperature reduced to true means.

Inasmuch, as between the Equator and 35° North and South Latitude, there are only very few stations existing—

35–30	30–25	25–20	20–15	15–10	10–5	5–0
1	0	2	2	1	2	0
Cape Town.		Rio Janeiro, Calcutta.	Bombay, St. Helena.	Madras.	Trevandrum, Batavia.	

whose daily march of temperature is known, *and not one of them has a continental situation*, the Congress should express the urgent wish, that by the introduction of hourly, or at least two-hourly, observations at suitable places, a commencement should be made to fill up this hiatus as far as possible. The systems of observations of Turkey, East Indies, Australia, the Southern States of the Union, and eventually Brazil, should be specially requested to institute such observations at inland stations.*

Reporter, M. Hann.

Appendix 2. to the Protocol of the Sixth Meeting. App., VI. 2.

Report of Sub-Committee III. on Question No. 14. (Evaporation observations.)

Question 14.

What apparatus is to be recommended for the measurement of Evaporation? What is the most suitable exposure for the Evaporation gauge (Atmometer)?† Evaporation, p. 29.

All atmometers as yet known may be divided into two groups:—

1st. Those in which the determination of the quantity of water evaporated is effected by *weighing* in a delicate balance, and

2nd. Those in which the evaporated quantity of water is ascertained by *volume*, consequently by *measurement*. From a theoretical point of view it is certain that the former method gives the most accurate results, but weighing twice a day, or even once a day, requires much time, and a delicate balance is required for it, the use of which presupposes a certain amount of practice. For the regular meteorological observations, evaporation gauges or atmometers of the second class are certainly more to be recommended.

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* Adopted at the Seventh Meeting (p. 29).

† It seems best to adopt Leslie's term for an evaporation gauge. It possesses the merits of seniority and of a correct classical derivation.

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App., VI. 2. Evaporation, p. 29.

The requirements which we have to expect from a good atmometer of this class may be laid down in the following propositions:—

a. The evaporating dish should not be too small, and if we are to aim at comparable results, the diameter as well as the depth of the evaporating dish must be absolutely identical in all apparatus. For smaller instruments an evaporating surface of 250 square centimetres (0·7 in. diameter); for larger ones, one of 1-10th square metre (14 ins. diameter) would be best suited.

b. The level of the water which is evaporating in the dish must remain *constant*, as the evaporation is less, the deeper the surface of the water stands under the edge of the vessel.

c. The measurement of the quantity of water evaporated must be made with the requisite accuracy, and it should be possible to read off the quantity of water evaporated in millimetres (0·04 in.) of depth.

In the choice of the apparatus we have first to regard the object which it is intended to attain. If the atmometer be to serve as a control for hygrometric data, and if it be wished to ascertain the influence of the individual elements of weather on evaporation, observations at least twice a day should be instituted; but for this purpose only the smaller apparatus is suited, and this should be erected similarly to the thermometer and hygrometer, sheltered from sun and rain.

If however the object of the observation be to ascertain the amount of evaporation under all circumstances which occur in nature, if the combined action of the elements of weather should express itself in the amount of evaporation, if the evaporation should thus in some measure serve as a representation of local climate, the apparatus must be left exposed to the action of the free air and the sun.

In this case we do not want readings daily, but only at intervals of about every five days, and the best form of apparatus that can be employed is the larger form, with a surface of 1–10th sq-metre (14 ins. diameter).

It is self-evident that the results of the large and small apparatus cannot be immediately compared with each other.

Inasmuch as according to the decision of the Congress, the receiver of the rain gauge should also be 1–10th sq-metre in size, we can by the help of this larger apparatus determine the difference between the quantity which has fallen and that which has evaporated, with much greater accuracy than with the smaller apparatus, and accordingly the former would be much better suited for practical purposes, as for instance, for Agriculture and Forestry, and for Sanitary Inquiries, than the latter.

A.—*Smaller Atmometers for Scientific Objects.*

Of the best known atmometers of this kind, Lamont's, Greiner's and Wild's apparatus may first be considered.

Lamont's atmometer has been used for three years at the Bavarian Meteorological stations with the best results.

The apparatus constructed lately by the optician Greiner in Munich is simpler and cheaper, and it also gives accurate results.

Wild's atmometer, in which the measurement of the quantity of water evaporated is ascertained by a bent-lever balance, has the advantage that it can be used in summer as well as in winter.

The instruments mentioned have all the disadvantage that in consequence of the progress of the evaporation, the surface of the water in the evaporating dish does not remain constant, but sinks. This error, which appears even in observations taken twice a day, is removed in Prestel's and Ebermayer's apparatus, of which the latter can be obtained from Greiner in Munich.

B.—*Larger Apparatus for Practical Purposes.*

Disregarding the most primitive evaporation gauge of this kind, which consists of a round or rectangular zinc vessel, of proper diameter, and which either contains, for the determination of the quantity of water evaporated, a vertical measuring rod (like a river pole), or which has a cock, by means of which the water can be let off into a graduated cylinder of glass, and measured. Dufour's Siccimeter should be noticed, which is described in Vol. VII. No. 8, p. 113, of the Austrian Meteorological Society's Journal, and serves to

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measure the difference between the rainfall and evaporation. As this apparatus can only be read after some days, the error which arises from the variable level of the water which is being evaporated is much more serious in this instrument than in the smaller apparatus of the first class. App., VI. 2. Evaporation, p. 29.

Closely connected with these instruments are those which serve to give the extent of the evaporation from the earth, and from the various kinds of soil in the shade as well as in the sun, covered or open. Experience of several years has shown that the evaporation apparatus of M. Ebermayer described in the recently published work: "Die physikalischen Einwirkungen des Waldes auf Luft und Boden," entirely fulfils its object.

As to the second question, which concerns the best mode of erection of the atmometer, it would be best to place the small atmometers of the first class (for scientific objects) under the same protection as that which is given to the hygrometer. Special care should be taken in setting them up, to give the air as free access as possible, to keep off the direct sun light, radiant heat, and rain water.

In the erection of the larger apparatus of the second class (for practical purposes) in the open air without any protection, the evaporating surface must be brought to the same level as the receiving surface of the rain gauge. The direct action of the sun on the sides of the apparatus must be prevented as far as possible, by enveloping it with bad conductors of heat (hay, straw, or moss); but the surface of water which is evaporating must be exposed to the complete action of the wind, and of the sun's rays.

It may also be recommended to plunge the apparatus partly into the earth, and in order to prevent water being removed from the evaporating vessel by animals, such as birds, &c., it should be covered with a wire net of large mesh. Wherever the conditions allow, it is desirable to plunge the atmometer in a lake or pond, to keep it floating, and to compare the results of *these* observations with those which have been obtained by means of apparatus placed on the open ground.

During winter months, when the freezing of the water causes damage to all the atmometers which have been described, measurements of evaporation can only be carried out with apparatus as simple as possible. The amount of evaporation is determined either by weighing or by measurement, when the ice is thawed. For the observations on a small scale, Wild's apparatus, above mentioned, seems to be the one best to be recommended.

For measurements on a larger scale, a *round* zinc vessel of 1–10th sq-metre area (14 ins. diameter) should be used, with a cock for letting off and measuring the ice melted. During winter months *both* instruments must be protected by a screen from the access of snow and rain. Inasmuch as the evaporation at a low temperature is only very slight, the inaccuracies attaching to this mode of observation cannot be of serious importance.

As the results to be obtained from atmometers have not yet been sufficiently determined, the Sub-Committee recommends:—

1. As a general rule, for the present, to introduce observations of evaporation only at meteorological stations of the first order.
2. By careful investigation to determine what will be the influence on the results of the nature of the material of which the apparatus is made (metal, glass, baked earthenware), as well as from the colour of the apparatus, and the height of the rim of the atmometer.*

Reporter, M. EBERMAYER.

Appendix 3. to the Protocol of the Sixth Meeting.

App., VI. 3.

Proposal of M. Wild:—

Does it not appear desirable that in order to investigate the weather phenomena of the higher strata of the atmosphere, more numerous observations should be made on isolated mountain peaks, as well as in captive balloons?† Observations in the upper regions of the atmosphere, pp. 36, 59.

* Adopted at the Seventh Meeting (p. 29), with the addition that the measurements of evaporation, by means of floating apparatus on large surfaces of water, should be introduced wherever possible.

† Introduced into the Report of the Seventh Sub-Committee (p. 59), and adopted at the Tenth Meeting (p. 36).

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App., VII. 1.

Appendix 1. to the Protocol of the Seventh Meeting.

LETTER from GENERAL ALBERT J. MYER to the CONGRESS.

Meteorological Congress, Vienna,
Sept. 11th, 1873.

To the Congress.

Synchronous observations, p. 32.

GENTLEMEN,

I HAVE the honour to submit the following proposition :—

That it is desirable that, with a view to their exchange, at least *one* uniform observation of such character as to be suitable for the preparation of synoptic charts be taken and recorded daily and simultaneously at as many stations as practicable throughout the world.*

I am, gentlemen, very respectfully,
ALBERT J. MYER, Brigadier General,
(Signed) Chief Signal Officer, U.S.A.

App., VII. 2.

Appendix 2. to the Protocol of the Seventh Meeting.

Acknowledgments of Receipts, p. 30.

PATTERN of a FORM for ACKNOWLEDGMENT of RECEIPT.†

St. Petersburg, Sept. 1872.

SIR,

I HAVE the honour to inform you that we have forwarded to you, through Messrs. Leopold Voss, of Leipzig, "Annals of the Central Physical Observatory, year 1870."

H. WILD,
Director of the Central Physical Observatory.

You are requested to be good enough to impress your stamp on the opposite side, immediately after the receipt of the above work, to tear off this second half of the form, and return it, in acknowledgment of receipt, as a prepaid letter, *unsealed*.

The undersigned has received from the Central Physical Observatory of St. Petersburg, "Annals of the Central Physical Observatory, year 1870."

. . . . . .

(Stamp of the receiver.)

Address (on back) :—
To
The Central Physical Observatory, &c. &c.,
St. Petersburg.

App., VII. 3.

Appendix 3. to the Protocol of the Seventh Meeting.

Thermometers, p. 32.

REPORT of SUB-COMMITTEE I. on QUESTIONS 2–6 (Thermometers and Hygrometers).

Question 2.

Exposure.

What mode of exposure of Thermometers for the observation of Air Temperature is the best and most suitable for general adoption?

The Sub-Committee considers it impossible to lay down fixed rules and regulations for general adoption in the exposure of Thermometers, because regard must be had to local conditions, and the mode of exposure which is most to be recommended, in a space which is open and accessible to all winds, and at a height of 1½ to 2 metres, cannot be used everywhere. As for the influence of height, M. Wild has carried on investigations at the request of the Leipzig Conference of the previous year, a special report of which will be furnished in a Supplement.‡ It appears from these investigations, which were conducted on an open scaffolding to a height of 80 feet, that if Thermometers are protected against radiation in the same way, the mean temperature is the same within an insignificant amount, and the difference of the results at various heights, at the same moment, amount on an average to less than 1°·8 F.

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* Adopted at the Eighth Meeting (p. 32).
† Adopted at the Seventh Meeting (p. 30).
‡ Supplement No. V. (p. 77).

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Mr. Scott reports that investigations have been begun on the same subject at the Chinese pagoda in the Royal Gardens at Kew to a height of 120 English feet; the results will be published later, when a sufficient series of observations is in existence. App., VII. 3. Thermometers, p. 32.

At the request of the Leipzig Conference M. Wild has also instituted investigations on the best method of protecting thermometers against Radiation from the soil and from neighbouring objects, in order to obtain as closely as possible the true temperature of the air. The results will be given in the Supplement,* as will be also a Report from M. Cantoni on the mode of exposure of thermometers and hygrometers at some of the chief stations in Italy.† According to the observations of M. Wild, as appears from his Report, the so-called rotary thermometer (thermomètre fronde) is not to be recommended.

In these reports all the precautions which should be recommended for the exposure of thermometers are to be found. It would be desirable that investigations on the influence of height and exposure should still be carried on at the central or chief stations.

Question 3.

What is the best construction of Maximum and Minimum Thermometers? Maximum and Minimum Thermometers, p. 82.

A report has been received from M. Cantoni, on an apparatus constructed by M. U. Marchi, of which a specimen has been submitted, and which has been introduced at Florence and Pavia, with good results. It would be desirable if experiments with this instrument could still be carried on at other stations, and among other things it should be tested how far it would resist the shaking of carriage and other influences. Against Casella's minimum and Hermann and Pfister's metallic thermometer, the result of long experience is that these instruments are frequently deranged, and that therefore they cannot be recommended for stations in which they cannot properly be controlled and regulated. For minimum thermometers it is better to adopt Amyl-alcohol, instead of ordinary alcohol, because the boiling point of the former is 356° F.?,‡ and therefore there is less fear of distillation. Finally, it should be recommended in all instructions for observers to add the rule:—*by continual comparisons of the indications of maximum and minimum thermometers with an ordinary thermometer placed beside it, to obtain a control on their uniform action, and the corrections which are to be applied to them.* As the Congress has fixed the end of the meteorological day at midnight, it is desirable that the maximum and minimum should be noted at the last observation of the evening, and entered on the day on which they are taken. Observations to be taken in the evening.

Question 4.

What instruments should be employed for determining the intensity of Radiation, and in what way can the comparability of the results obtained be ensured? Radiation, pp. 32, 83, 87.

A report from Mr. Symons has been received on the instrument which has been used by many observers for several years in England, of which a copy is laid before us.§

According to this report we can obtain quite useful and comparable results of the intensity of Radiation, by the difference of temperature between this instrument when exposed to the sun, and a thermometer in the neighbourhood in the shade. On the other hand, it may be remarked that a thermometer contained in the exhausted envelope is exposed, not only to the direct action of the sun's rays, but also to the radiation of objects standing near and exposed to the sun, and, furthermore, that the air surrounding the apparatus may have a different temperature from that surrounding the thermometers in the shade. From the experiments that M. Soret conducted for several years at Geneva and other stations, and published in the "Archives des Sciences Physiques et Naturelles" it is proved that a very special and complicated arrangement must be adopted, if it be wished to obtain an accurate and

* Supplement No. V. (p. 77).
† Supplement No. VI. (p. 80).
‡ For 356° read 279° ·6 F. (R. H. S.) The true boiling point is 279° ·6 F. (Pierre.)
§ Supplement No. IX. (p. 87).

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App., VII. 3. direct measurement of the Radiation, which shall be free from all other influences. Experiments on this subject are recommended to physicists and directors of the central and normal stations, but cannot as yet be brought into the sphere of regular observations.*

Question 5.

Earth Temperature, pp. 32, 88.

What apparatus is best for determining Earth Temperatures?

At what depths should the observations be taken in order to attain the uniformity which is desirable?

Reports on this subject have been received from Professor Bruhns and Director Wild, and are added in the Supplement.† From the experiments of Professor Bruhns it is clear that Lamont's method, with the use of a wooden tube, gives more trustworthy results than the thermometers with long tubes which reach into the ground, because in the latter the influence of the metal case affects the accuracy of the reduction. But on the average of the year the differences nearly compensate each other. From the same experiments it appears that the aspect in which the thermometers are sunk has a great influence, and so has also the nature of the soil, so that attention must be paid to these circumstances, in order to obtain comparable results.‡ Director Wild has begun experiments with a thermo-electric chain, and instituted comparisons with the results obtained by Lamont's method, but these experiments are not finished, and are being continued.

As to the second question, the depths at which the observations were made in Leipzig and St. Petersburg were not quite the same, and the greatest depth is not more than three metres. New experiments should therefore be recommended in other countries, in order to decide the question at what depths observations should be taken.

Question 6.

Humidity, p. 33.

What apparatus should be employed for the determination of the Hygrometric Condition of the air?

Are the wet and dry bulb thermometers sufficient?

Can the Hair Hygrometer be employed, and under what restrictions?

Although the defects of the Dry and Wet Bulb Hygrometer are not to be denied, and it is most important to recommend to physicists experiments towards the discovery of new apparatus, and some other method for the determination of Humidity, yet that hygrometer cannot as yet be replaced by any other instrument. The use of hair hygrometers can only be made with safety, if their indications are constantly controlled by comparison with the psychrometer, and their corrections from time to time determined, especially near the point of saturation, where they often give too low readings. According to the experiments of Director Wild, the psychrometer gives very good results down to 0°, if only care be taken, as soon as the temperature falls to near 32°, to wet the bulb half an hour before the observation. As this operation can frequently not be carried out with the necessary care at stations of the second order, the experiments in Russia lead to the conclusion that the use of the hair hygrometer can be recommended under the former conditions, especially for low temperatures. Finally, experiments on the applicability of usual tables for hygrometric reductions in damp or in very dry air are very much to be recommended, and especially the experiments of M. Cantoni, according to which the production of an artificial movement of the air about the psychrometer brings its results into uniformity with those of the chemical method, whatever the degree of humidity may be: these should be repeated under other climatal conditions.§

p. 84.

Reporter, M. PLANTAMOUR.

* The Congress resolved at the Eighth Meeting (p. 33) that it would express its recognition of the services of Messrs. Symons and Stow, who, of their own accord and at their own expense, had instituted extensive series of observations, and had deduced valuable results therefrom.

† Supplement No. X. (p. 88). Prof. Wild's paper not given in German original.

‡ In regard to the influence of the nature of the soil, and especially to the amount of moisture in it M. Cantoni gives the results which have been obtained in the Po valley, in the plains which have been flooded for the purpose of rice cultivation, according to which in the summer months, temperatures at a depth of 5 c.m., remained constant during the daily and monthly periods. This must be attributed to the evaporation.

§ Adopted at the Eighth Meeting (p. 33).

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Appendix 1. to the Protocol of the Eighth Meeting.

App., VIII. 1.

REPORT of SUB-COMMITTEE VII. on QUESTION 28, respecting the carrying out of the Decisions of the Congress, and the completion and extension of the existing system of Observations.

Resolutions of Congress, p. 31.

It being considered self-evident that the delegates who are present here will consider themselves pledged to use their utmost efforts to induce their respective Governments to adopt the decisions and wishes of the Congress, the Sub-Committee makes the following further proposals:

a. To express to the different Governments the wish that a new International Congress should be convoked in three years' time.

b. In the meantime to determine on the appointment of a Permanent Committee.

The Committee should consist of seven members chosen by the present Congress, and should have the right of completing itself in case of the resignation of any members, and if judged expedient reinforcing itself by the addition of new members.* The president shall also be chosen by the present Congress.

The Committee will have the duty of taking care for the carrying out of the decisions of the Congress, and of arranging for the convening of a future Congress; and it shall, by continual communications, place the delegates of the present Congress in cognizance of its action and proceedings.

The Sub-Committee further recommends that the Congress shall indicate the following rules for the extension of meteorological knowledge as desirable and very useful:— p. 36.

α. The establishment of permanent stations of observation on high mountain tops, if possible, provided also if possible with self-registering apparatus.

β. The institution of experiments on the possibility of making continuous Meteorological Observations with captive balloons.

γ. The institution of Meteorological Stations in the North Polar regions, the meteorological conditions of which are as yet either very slightly or not at all known, and in the first place at Spitzbergen.

δ. The institution of new supplementary stations on the north coast of Africa, as well as the regular publication of the observations which already exist on this coast.

ε. The more perfect organization of the stations in Turkey, and especially the central observatory at Constantinople, with regard to the advantage which is to be expected, both for science and navigation.

ξ. The maintenance of the Meteorological Station at Athens, and the publication of its observations.†

Reporter, M. HOFFMEYER.

Appendix 2. to the Protocol of the Eighth Meeting.

App., VIII. 2.

REPORT of the EIGHTH SUB-COMMITTEE on the proposed Establishment of METEOROLOGICAL STATIONS in CHINA.

The Sub-Committee have read with great interest the documents which have been submitted to them by Mr. Campbell, on behalf of Mr. Hart, the Inspector-General of Customs for China, and they would commence their report by offering to the Chinese authorities their sincere congratulations on the public spirit and the desire to further physical science in every way which is evinced by the letters of Mr. Hart. China, p. 33.

Many of the matters touched on by Mr. Hart are such as hardly require an authoritative opinion from the Congress, but it will be convenient to notice Nos. 2, 3, and 4 of the memorandum of March 11, 1873, taken in connexion with the views of the Astronomer Royal for England, also submitted to the Sub-Committee.

* Adopted at the Eighth Meeting (p. 31) in the following form:—"The Committee has the "power to fill up the places of members who resign, and, if found expedient, to increase itself "by the co-option of two members at most."

† Adopted at the Tenth Meeting (p. 36), with the modification that to section γ the following words were added:—"and also in high Southern Latitudes."

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App., VIII. 2. China, p. 33.

2. "Instruments to be procured to bring observations into accord with those of stations elsewhere established."

On the subject of *scales*, the Sub-Committee recommends the employment of the Metric scale and the Centigrade Thermometer.

They recommend the following supply of instruments for the ordinary stations, which should all be verified by competent authority :—

Barometers, Kew pattern, two in number, with a large Aneroid, to be used in case of emergency, when the mercurial barometers are out of order, &c. &c.

Thermometers, to be graduated on stem to 0°·2 C. to range from −30° to 60°, six in number, for fear of accidents, of which two will be used for the Hygrometer.

Maximum Thermometers, two in number, Negretti and Zambra's pattern.

Minimum Thermometers, two in number, Rutherford's pattern.

Furthermore, M. Jelinek recommends that a Hair Hygrometer (Saussure's), made by Hermann and Pfister, in Berne, should be provided for each station, to meet the difficulty of hygrometric registration with the Hygrometer at low temperatures.

Rain Gauge, Glaisher's pattern, and of the size recommended by the Congress* in case of all future orders.

Wind to be estimated, or the simple apparatus recommended by the Congress to be employed.

3. "Registers similar to those in which stations elsewhere record their observations."

It is hoped that the present Congress will recommend a form of register for general adoption.

4. Printing of observations, &c. &c.

As to the publication of data, the opinions of the present Congress will, it is hoped, be universally adopted, so that it is not necessary to dwell on this point.

The observations to be taken would be those which are expected from stations of the second order, where more than four observations a day are not obtainable.

They should refer to *Pressure*, *Temperature*, *Hygrometry*, *Rain*, *Wind*, *Cloud*, and *Weather*, with especial notice of extraordinary phenomena.

The special subject of Weather Telegraphy has been treated more fully in the memorandum of April 15th, 1873, but the Sub-Committee cannot, without a knowledge of the special requirements of the China seas, attempt to enter into details on this question.

The establishment of Weather Telegraphy in China cannot fail to be of the highest importance, and the experience to be obtained from Brigade-General Myer, of Washington, Mr. Blanford, Meteorological Reporter for Bengal at Calcutta, and Mr. C. Meldrum, Secretary of the Meteorological Society of the Mauritius, will probably be of considerable practical value.

The Sub-Committee are of opinion that the arrangement of the duties of such a system cannot be effected except by an officer specially charged with the direction of the entire system.

Such an officer is absolutely requisite, and he should be entirely independent of the proposed chair of Astronomy in the Peking College, as suggested in the memorandum of March 11th, 1873, already cited.

A considerable portion of his duty would consist in travelling about to establish and inspect his stations, and he would require, at least at first, the assistance of a skilled mechanician who could erect the instruments with his own hands at each station, and could effect certain slight repairs which are constantly requisite at Meteorological Stations.

The Sub-Committee consider that there should be four stations of the first order, of which *Shanghai* should be the chief. The others should be *Peking*, *Hankow*, and *Amoy*. These stations should have an outfit of the best instruments obtainable, and should perhaps have appliances for verifying instruments received from Europe.

It will, of course, be understood that as the stations must be established under the personal inspection of the officer to be charged with the control of the system, it will necessarily require some time before they can all be in operation.†

Reporter, ROBERT H. SCOTT.

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* 14 ins. diameter (p. 52).

† Adopted at the Eighth Meeting (p. 33), with the modification that the employment of English Units of Scale (Inches and Fahrenheit Degrees) was declared admissible.

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Appendix 1. to the Protocol of the Ninth Meeting.

App., IX. 1.

Report of Sub-Committee VI. on Questions 22–25 respecting Organization.

Organization, p. 36.

On Question 23 —

Is it desirable that in each country there should be established one or more Central Institutions for the direction, collection, and publication of the Meteorological Observations?

A discussion took place and a decision was adopted at the Leipzig Conference.

The Sub-Committee proposes that the first portion of the Leipzig Report should be adopted, but that the second portion should be handed over to the Sub-Committee for Maritime Meteorology for a report. As a resolution on this question it is therefore proposed :—

1°. The Congress considers it necessary that in every country at least one, but in case of necessity several, Central Institutions, should be established for the management, collection, and publication of Meteorological Observations.

On this occasion the Sub-Committee considers it necessary, in order to determine the ideas, to propose the following definitions of the various classes of meteorological observing stations :—

(*a.*) *Central Office*, or *Central Institute* is the chief office entrusted by the Government with the management, collection, and publication of the Meteorological Observations of the country.

(*b.*) *Central Station* is a subordinate centre for the management and collection of observations from a certain province.

(*c.*) *A Station* of the *First Order* is an observatory in which, without the collection of observations from other stations, Meteorological Observations are conducted on a great scale, *i.e.*, either by hourly readings or by the use of self-recording instruments.

(*d.*) *Stations* of the *Second Order* are the stations where complete and regular observations on the usual meteorological elements, viz., Pressure, Temperature, and Humidity of the air, Wind, Cloud, Rain and Hydrometeors, &c., are conducted.

(*e.*) *Stations* of the *Third Order*, finally, are the observing stations, where only a greater or less portion of these elements are observed.

In reply to the first part of Question 24 —

Can rules universally applicable be laid down for the Verification of Instruments and the Inspection of Meteorological Stations?

The Sub-Committee makes the following proposal :—

2°. The Congress considers the careful verification of all the instruments which are to be distributed to the Meteorological Stations, as well as the inspection of stations of the first and second order to be necessary, and the latter should take place if possible yearly, but at least once in the course of every five years.

As to the method of the regular inspection of Scotch Meteorological Stations, Mr. Buchan has submitted a report which is appended to this report, and which is printed in the Supplement,* but the Sub-Committee does not think it possible to institute rules of general applicability on this question, and therefore only proposes the following resolution on the subject :—

3°. The mode of verification of the instruments and of regular inspection is left to the decision of the Central Offices, and the Congress only expresses the wish that with regard to the instrumental errors which are thereby detected, corrected results only should be published, but that the amount of the corrections which have been applied should be given.

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* Supplement No. xii. (p. 93).

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App., IX. 1. To the second part of Question 24—

Organization. General Instructions. p. 36.

And is it advisable to introduce general instructions for taking and calculating Meteorological Observations?

the Committee proposes as a reply:

4. The Congress recommends the Permanent Committee, if possible by April 1874, to prepare Instructions for the institution and discussion of Meteorological Observations, to distribute them then in separate copies to all members of the Congress, and subsequently, if possible, after paying all possible attention to the remarks which have been received, to proceed, at the latest in June, to edit and publish them definitively.

Question 25 runs:—

In what manner can the agreement of the Standard Instruments of the different central establishments be best effected?

Standard Barometers. p. 36.

The Sub-Committee is of opinion that this question only refers to Standard Barometers and Standard Thermometers.

As far as concerns Standard Barometers the Sub-Committee considers the usual comparison of various standard barometers by travelling instruments as quite insufficient, and propose therefore:—

5. The Congress recommends all central offices to adopt real standard barometers, *i.e.*, instruments which allow of the determination of atmospheric pressure according to its definition in absolute measure. The Permanent Committee is commissioned to determine the conditions which such an instrument should fulfil.*

Standard Thermometers. p. 36.

With regard to the Standard Thermometers, the Sub-Committee considers the following rule as the best:—

6. The Congress recommends all central offices to forward all the Kew Standard Thermometers, which they either already possess, or will presently procure, to a gentleman to be indicated by the Permanent Committee, who shall be entrusted by it with the careful comparison of all these with each other, and, if possible, also with the Air Thermometer.

The Kew Committee, according to the statement of Mr. Scott, will always be ready to furnish Standard Thermometers to Central Offices.†

Reporter, H. Wild.

App., IX. 2.

Appendix 2. to the Protocol of the Ninth Meeting.

Report of Sub-Committee V. on Maritime Meteorology.

Question No. 22 runs:—

Marine Meteorology, p. 36.

In what way can Maritime Meteorology be best introduced into the system of General Meteorology?

The Chairman of the Committee, M. Buys Ballot, suggests the following proposals for discussion:—

1st. The Sub-Committee declares it to be very desirable that each country should, if possible, collect all its meteorological observations at one place, in order to undertake the organization of the investigations at the same place. The Institute should be established as near as possible to the sea.

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* Adopted at the Tenth Meeting (p. 36), with the modification that at the same time the comparison by means of good portable barometers should not be rejected, and that the Permanent Committee be instructed to investigate the best manner in which the comparison of the Standard barometers at the several Central Offices can be effected.

† Adopted at the Tenth Meeting (p. 36), with the following modification:—"The Congress "considers it to be the business of each Central Office to prepare a Standard thermometer for "itself on scientific principles, and it recommends all Central Offices, &c."

At the same time it was resolved to request Mr. Scott to convey to the Kew Committee the thanks of the Congress for their readiness to furnish standard thermometers to the individual Central Offices.

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2nd. The Sub-Committee is of opinion that the Institute for Maritime Meteorology, named in the first proposition, might best be placed under the general management of the Chief Institute of the country.

App., IX. 2. Maritime Meteorology, p. 36.

These two proposals were adopted unanimously. Whereupon a lengthened discussion took place on the third question.

3rd. In what way should this Maritime Institute work?

The Sub-Committee is of opinion that the resolutions of the Leipzig Conference on the subject of Maritime Meteorology should be upheld.

The proposals in question of the Leipzig Conference run as follows:—

" 1st. Thorough uniformity in methods and instruments should be aimed at in the same measure as for observations on shore. This will be most satisfactorily attained by the chiefs of the central institutes—the establishment of which in all countries, in which they do not already exist, and in which the maritime interests demand them, must be declared as absolutely necessary—entering into relations with each other and agreeing on the separate details, the construction of the instruments, the hours of observation, the journal, &c.

" 2nd. Unity of measures and scales is desirable, and to this end the introduction of millimètres for the barometer and the centigrade scale for the thermometer should be aimed at. While, however, the comparison of standard instruments of the individual central stations must be insisted on, the uniformity of scales is at present only declared as desirable.

" 3rd. The committee would urge the importance of the co-operation of the navies, inasmuch as by their assistance, and by the opportunities afforded thereby of completeness in certain observations, the determination of factors and constants is rendered possible, which can be used with advantage for the reduction of certain results derived from the general system of observations.

" 4th. With reference to the utilisation of the results, the committee would urge similarly the importance of uniformity in the methods employed. In close relation therewith was the carrying out of the division of labour of the central stations of the individual states. This principle must be recognized as of the greatest importance for the further development of Marine Meteorology. The repetition of work over definite regions, with reference to the area to be investigated, must be declared as indefensible in the interests of this development."

Mr. Scott repeats the statement already made at the Leipzig Conference that the Meteorological Office in London would not be in a position to undertake the copying of observations *gratis*.

Finally the Sub-Committee adopts the proposal of M. Neumayer in the following words:

In consideration of the fact that it will not be possible to devote to Maritime Meteorology at the present Congress a comprehensive consideration, corresponding to its importance, but, on the other hand, as it seems that a mutual understanding of the individual maritime nations in regard thereto is necessary, the Meteorological Congress declares that the convening of a Maritime Meteorological Conference is desirable.

The preparation for this Conference is to be entrusted to a Sub-Committee, to be named by the Congress.*

Reporter, R. H. Scott.

Appendix 3. to the Protocol of the Ninth Meeting.

App., IX. 3. p. 37.

Report of Sub-Committee V. on Weather Telegraphy and Storm Warnings.

The Sub-Committee has adopted as a basis of its discussion the six questions which have been proposed by MM. Buys Ballot, Neumayer, and Scott, who

* Adopted at the Tenth Meeting (p. 37), with the modification that the Permanent Committee was entrusted with the measures for the preparation of the Marine Conference.

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App., IX. 3. Weather Telegraphy, p. 37.

had been entrusted by the Leipzig Conference with the duty of discussing the question of the practicability and utility of weather telegrams and of storm prognosis, and it has arrived at the following results:—

Question 1:—

What are your opinions in respect of the action of the systems of Storm Signals hitherto in use, either from your own experience, or from a consideration of the Bulletins published in the United States, in England, and in France?

It is sufficiently evident, from the various answers of the scientific men who have been asked for their opinion, as well as from the other official and non-official reports of the individual Directors of Meteorological Institutes, that there is a general conviction of the importance of Weather Telegraphy for the purposes of practical life, and that the existence of such a system is considered a necessity. This is shown from the results obtained hitherto from the systems already in existence.

The Sub-Committee therefore expresses its opinion in the following words:—

It seems desirable that the system of Weather Telegraphy should be developed as generally as possible, and on as uniform a plan as possible. In all countries in which up to the present time such systems have not been organized, steps leading to such an organisation should be taken as soon as possible.

The Sub-Committee is further of opinion that it would be desirable to institute this organization on the following principles:—

1. The systems of observation which are already organized or to be organized in the various countries should be in as close relation to each other as possible, and this is of importance, not only with reference to the general arrangement, but also especially with reference to the telegraphic communications.
2. The system of each country must have a Central Office, which, if possible, should be combined with the central office for Maritime Meteorology but, in any case, like the latter, must be subordinate to the Central Institute in each country. The observing stations belonging to the system should be placed under the central office for Weather Telegraphy and Storm Warnings, and their officers must be always ready to send to this Central Office weather reports, or to answer its inquiries for information.
3. The observers at the stations belonging to the system must be well instructed, for the purposes of Weather Telegraphy.
4. The choice of a locality as a station for Telegraphic Weather Reports must be made with consideration to all local circumstances and requirements, and with especial reference to the Wind; furthermore, with reference to the series of observations which have already been recorded and reduced for the station, and with reference to the general system. Regard must also be had for the interests of the adjacent systems. But the final decision must always rest in the hands of the respective directors.
5. In order to make the system of warnings as perfect as possible, according to the present state of the Science, the Sub-Committee must indicate that it is desirable that the observations and reports based thereon should be made as complete and continuous (as regards the former) as is possible, *i.e.* neither Sundays nor holidays should make a difference to them, and there should not be a complete interruption during the night.
6. Representations should be made to the respective Governments to facilitate Weather Telegraphy as much as possible. This is of importance, not only with reference to the expense, but also with reference to time, in respect of the telegrams within each system, and from one central office to another. If Telegraphic Weather Reports are delayed from the consideration of other despatches, the operation of the system will, in the opinion of the Sub-Committee, be seriously interfered with.

It is desirable, in order to carry the arrangements which are required according to the above views, that the respective Governments in granting a

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concession to a private telegraph company should take care that most thorough regard should be paid to the interests of Weather Telegraphy.

Question 2—

Is it your opinion that in addition to communications of the Direction and Force of the Wind which is actually blowing, the Barometrical "Gradients" should be given, in order to give warning of approaching wind?

To what should these Gradients be referred? Viz.:

A—To the differences between the actual readings at the different stations.

B—To 30 ins., at sea level.

C—To the mean normal heights of the barometer at the stations taken into consideration.

With reference to this question the Sub-Committee is of opinion that besides communications of the Direction and Force of the Wind, the Barometric Gradients at the time of observation should also be added, in order to give warning of the wind which is coming.

Although the concordance of opinion within the Sub-Committee, with respect to the first part of the question, is great, this cannot be asserted with reference to the second part, inasmuch as the opinions of the scientific men who have been consulted are partly for the mode of reduction given under B, and partly for that given under C.

However the various opinions within the Sub-Committee have been brought to agreement on this point, that for stations which are not above 300 metres above the sea, the reduction of the barometer readings to the Mean Sea-Level will be admissible. This agreement was attained with special reference to the drawing of isobars for the purposes of Storm Warnings, and in recognition of the theoretical difficulty of carrying out this method of reduction for elevations greater than those named.

Question 3—

In what way should we take into consideration Temperature, Vapour, &c., &c.?

With regard to Temperature and Moisture, as well as with regard to Cloud, Appearance of the Sky, State of the Sea and Tides, and Precipitation, it was recommended by most of the gentlemen consulted that some attention should be paid to these subjects; but in what way attention should be paid has not been indicated by any of them; therefore the Sub-Committee is of opinion that this question should be considered as not answered, and it therefore recommends its examination most specially to the notice of scientific men who occupy themselves with the study of storms and their causes, and draws attention to the investigations in this direction by Dove, Mohn, Rev. Clement Ley, Peslin, Buchan, and Reye.

Question 4—

If we assume that each Director will institute the proper arrangements in his own district, what do you recommend as a minimum that each Director should communicate to the Director of another district, and should receive from him in return?

The answers to this question must be considered as a *resumé* to those given to Questions 2 and 3, and they have frequent reference to communications within one and the same system, but not to the mutual communications between the directors of the individual systems. The Sub-Committee is of opinion that a distinction should be drawn between the theoretical and practical treatment of the question. For theoretical investigations all the elements are requisite and they should all be taken into consideration, but this can take place at any subsequent period. For practical purposes, with regard to which each director must consider the special requirements in his own country, they must be confined to a minimum.

It is sufficient that each director of a district should receive from his neighbour, as a minimum of what is to be communicated, the following elements:—

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App., IX. 8. Weather Telegraphy. p. 37.

Wind, according to Direction and Force, Pressure (including the Pressure for the evening of the previous day); Air-Temperature, Humidity, amount of Rain, Cloud, Weather, Sea, and when atmospheric disturbances are approaching, the magnitude and direction of the most important and most recent Gradient.

The Sub-Committee is further of opinion that these data should all be sent reduced, in order that a more rapid treatment of the materials should be rendered possible.

It must be left to the individual directors to determine among themselves the arrangements of a more special nature. This has special reference to the magnitude of the gradient which should be considered as an indication of atmospheric disturbance.

Whenever the International Institution, which is considered as very desirable by the Congress, is called into existence, all the evening observations should be sent to it, in order that a general view of the conditions of the weather of the whole of Europe can be given early in the morning to the individual systems.

Question 5—

Are you of opinion that the present condition of our weather knowledge justifies us in issuing distinct prophecies or forecasts of weather in contradistinction to the simple Telegraphic communication of facts, or should we confine ourselves to indications of the condition of the atmosphere in adjacent countries, from which the recipients of the Report must draw their own conclusions? In the latter case should we communicate the general conditions by Signals visible from a distance, posting up, at the place itself, the detailed information received from other localities?

Question 6—

In what way can it be arranged that intelligence of the conditions of weather can be conveyed to ships at sea, by means of Semaphores or by Signals from Lighthouses?

From an analysis of the various opinions on the practicability of storm-warnings which have been received, it appears that the great majority have declared *for* Storm-Warnings.

If we give to the opinions of individual societies, as well as to those of prominent authorities on the subject of Storm-Warnings, a weight = 10, to the other practised investigators of this subject a weight = 5, while less experienced men receive a weight of 1 or 2, the result is as follows:—

For Storm-Warnings of a more or less detailed and decided character, but certainly *above* the simple communication of facts, we find 72 votes. Against Storm-Warnings, and for restriction to a communication of facts, only 24 votes.

The majority of the opinions which have been received tends to the view that these warnings should be given in connexion with communications of facts, only a few hold these communications as quite unnecessary, while other and important voices are only for communication of facts without warnings; but it must be kept in mind that almost all the opinions expressed refer to the north and north-west of Europe, and are only in the first place to be understood as applicable to these districts; in fact the limits should be drawn even more narrowly, it being only the coasts of the districts described which are meant.

On these grounds the Sub-Committee expresses its opinion that Telegraphic Weather Reports have become a necessity, as has been proved by the answers to the first question, and furthermore that the results of the systems which have been or are to be organized for this purpose, can and must be utilised by the communication of simple facts of weather, with such developments, in the sense of storm-warnings, as may be justifiable by the further development of our knowledge of atmospheric disturbances.* The results which have been

* This sentence differs from the German original, Dr. Neumayer having pointed out a misprint in the latter, which made the sense unintelligible. The present version is submitted by Dr. Neumayer.—Trans.

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obtained empirically, and by the statistics of weather knowledge, can be utilised for the benefit of navigation and agriculture, &c.

In the present condition of the development of weather prognosis, the matter of most importance is to define as accurately as possible, the character of that which comes under the head of communication of facts. Among all the opinions which are submitted there is not a single one which does *not* reject for weather prognosis the title of *prophecies* or *predictions*. The most decided protest is lodged by everyone against the idea of infallibility being implied in this use of such a term. All that is said, is, that "an opinion should be given on the "weather to be expected,—or probability of the approach of a storm should be "given—or possibility of prediction of wind, direction and force, &c."

In the opinion of the Sub-Committee, a considerable difficulty in the practice of storm warnings consists in the careful avoidance of too special indication of probable wind and weather. The objection which is made by several of the gentlemen whose opinion was asked, that the reports would be discredited, owing to non-fulfilment of the "prophecies," loses its force if only such atmospheric disturbances are communicated, as will probably be accompanied by serious results. Accordingly warnings by signals should not be issued for winds of forces 5 to 7 of Beaufort's scale, but above those numbers. Such warnings would meet with fulfilment with incomparably greater certainty. On the other hand, according to the experience which has yet been made, only few dangerous phenomena would escape notice. A general rule for storm gradients cannot be given, as many of them will be of a local nature; the director must therefore gradually form his opinion on this question, according to his experience, so that in the opinion of the Sub-Committee it appears desirable that actual storm warnings should not be attempted in newly organized systems immediately after the establishment of the system, but that the director should first gain for himself the experience necessary for the purpose.

If we were in a position to give from time to time, by means of signals, the accurate definition of the communications on conditions of weather, and on the indications of coming weather, the greatest portion of the difficulty would be removed; still we must endeavour to meet this difficulty by notices posted up on flagstaffs, containing explanations of the weather, and the opinion of the director thereon, which must somehow or other be more widely communicated.

This, however, can only have reference to communications in harbours, while for ships passing at a distance, and at sea, means must yet be found to give them an explanation of the signals.

In consideration of all these circumstances, and on the supposition that the conditions indicated in the answers to Question 1, will be strictly fulfilled, the Sub-Committee expresses its views on this very difficult question in the following words:—

1. Communications on the state of the weather should be given by telegraph by the central office to the public daily, and, wherever possible, twice a day, in the first place with reference to the objects of practical life, and especially of navigation.

These communications should be distributed as widely and as rapidly as possible by publication in the newspapers, or by synoptic charts, &c., with opinions on the conditions of the weather. The extent of these communications must be regulated by the means at the disposal of each system, and therefore nothing determinate can be settled on the question.

In case of disturbances in the atmosphere which are expected or have already commenced, telegrams should go to the signal stations, harbour-masters, &c., and rapid distribution must be afforded to them.

2. With reference to these latter telegrams—in cases of atmospheric disturbances—the following distinction may be drawn, according to the opinion of the Sub-Committee.

a. If they are intended for ships lying in larger harbours, in order to afford their captains the opportunity of forming an opinion of a disturbance which is expected, and perhaps has already commenced to be developed, it is possible by a suitable apparatus, perhaps by the *aeroclinoscope* in a somewhat altered form, to bring to the knowledge of the public the

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App., IX. 3. Weather Telegraphy. p. 37.

conditions of pressure, motion of the wind, &c. Moreover, the receipt of the information must also be announced at the signal stations, and at the open spaces of the harbour, in forms prepared for it, and must be posted up.

While the public thus interested obtains an idea of the progress of the disturbance not only at the locality itself, captains, from the movements of their own instruments on board, and from comparison with the telegrams, can form for themselves an opinion on the state of affairs.

b. If such telegrams are intended for harbours for small shipping, fishing, &c., in which case meteorological instruments cannot be supposed to be in the hands of the receivers, any more than a complete comprehension of the rules according to which the disturbances take their course, the apparatus mentioned above can be of little use.

Explanatory notices from the central office, posted up, are therefore above all things necessary, while that office has also to take care that at any very little port of this kind, a barometer and a thermometer are erected at easily accessible places.

3. In consideration of the circumstance that we cannot pre-suppose in the receivers of the communications the degree of meteorological knowledge which is requisite for drawing correct conclusions from the conditions of wind and weather, and from the movement of the meteorological instruments, and, moreover, that these receivers necessarily cannot come into possession of the requisite information until many hours later than the central office,—and inasmuch as the rapid progress of the development of a disturbance hardly leaves them any time for independent prognosis,—and in further consideration that our knowledge, being gained in an empirical way, puts us in a position of being able to foresee for certain districts the course of the atmospheric disturbance, the Sub-Committee is of opinion that the Director of the Central Office should give his opinion on this probable course of atmospheric disturbances which are expected, or have already commenced, not in the form of a prophecy, but in the form of *probabilities*. This opinion must be brought to the knowledge of the public by the Director in question, according to his own circumstances, by the printing and posting up of notices.

It is only when from the conditions of pressure, serious storms of 7–8, according to Beaufort's scale and upwards, are to be expected, according to the opinion of the Sub-Committee, that the views of the directors of the central offices on the direction, course, and force of the storm should be announced by signal apparatus on prominent points of the coast and in harbours and roadsteads.

The Sub-Committee is further of opinion that complicated apparatus cannot be recommended for this object, and proposes, therefore, the use of the drum and cone by day, and the corresponding signal lanterns by night, and recognizes that an expansion of this system of signals, as by the addition of a truncated cone, will be desirable; but under any circumstances the warning signals must be International.

4. In order to insure for these Storm Warnings, which are a benefit for shipping, as great effectiveness as possible, and to avoid misunderstanding, the Sub-Committee considers that the issue of explanations for the comprehension of the signals is very desirable. These explanations should contain, in a series of propositions, explanations of the signals and their meanings for various cases serving as illustrative examples, which propositions can be applied to the several signals in some manner which has yet to be determined.

The Sub-Committee is of opinion that while some such course of action would afford protection against misapprehension and discredit of the warnings issued, the public will gradually be educated by it to a clear comprehension of the reality and meaning of weather prognosis.

6.* Such an explanation cannot, according to the nature of the case, be the same for all coasts and waters, and must, therefore, be prepared in consideration of that, but should certainly be international and added to every Code of Signals.

7.* Finally the Sub-Committee requests the Congress to express its opinion

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* So in original; No. 5 is omitted.

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that on the part of the respective Governments, action should be taken to perfect as far as possible the storm-signal system, especially the apparatus and the explanations for the comprehension of the signals, and that special investigations and inquiries which are calculated to promote the signal system should be most warmly supported.*

App., IX. 3. Weather Telegraphy. p. 37.

Reporter, M. NEUMAYER.

According to a resolution of the Congress at the eleventh meeting on the 16th September 1873, the following proposal of M. Hoffmeyer is to be introduced into the foregoing report of the Sub-Committee.

M. Hoffmeyer's proposal for afternoon telegrams, p. 38.

As it is, in my opinion, of the greatest importance to be able to give the daily meteorological communications as early in the morning as possible, I permit myself to draw the attention of the Congress to the question whether it would not be desirable that these communications should be principally based on the observations of the previous evening. If a well-constituted central institute could receive telegraphic despatches every evening from a sufficiently large number of European stations, in order to be able to deduce from them a *resumé* of the general meteorological conditions, these *resumés* could be communicated to the respective national systems during the night, or else very early in the morning, in order to be utilised in communication with the despatches of the individual stations received in the morning.

The special national systems would, therefore, not only obtain a better and more complete grasp of the circumstances, and of the changes of the great barometric maxima and minima, but by such a centralisation of evening observations, it would be possible to content ourselves in each individual system with morning telegrams from a more limited area than at present, when almost every meteorological institute is compelled gradually to extend its meteorological network on all sides, far over the frontiers of its own country, in order to obtain the requisite knowledge of the weather conditions. The telegrams from foreign and distant stations arrive so irregularly and so late, that the daily weather summaries, as well as the storm warnings, cannot be published before noon, or even later, while they could be ready at least two hours earlier if they depended only on the telegrams of a smaller area.

* Adopted at the Eleventh Meeting (p. 38).

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SUPPLEMENT.

Suppl. I.

I.

Prof. Wolf.

EXTRACT from a CIRCULAR addressed by PROFESSOR RUDOLF WOLF to the OBSERVERS of the METEOROLOGICAL STATIONS in SWITZERLAND, 12th July 1873.

I HAVE used the opportunity of the meeting of the Geodetical Commission, on the 11th May 1873, which brought me into contact with Professors Plantamour and Hirsch, to prepare a few important notes for a programme for the Swiss delegate at the Congress at Vienna.

We agreed upon the following points:—

International stations.

1. That he should urge that Switzerland, in consequence of its character, should have *more* international stations than would be allowed to it according to its superficial extent; as a minimum, five stations, in which, in the first rank, St. Bernard and Geneva; next Chaumont: then, for northern Switzerland, Zürich or Basle, and, finally, for southern Switzerland, Castasegna or Lugano. These stations, if adopted into an international réseau, will form the *normal stations* of the country, to which, as required, a larger or smaller number of *secondary* stations will be added. The former should be inspected yearly; the latter at least every two years, by the Central Office of the country.

Instruments.

2. That he should maintain the view that, in general, even for the normal stations, the outfit which has hitherto been usual for the Swiss stations—Barometer, Thermometer, Psychrometer (if possible, with the addition of a Hair Hygrometer for times when the last-named instrument is out of action), and a Rain Gauge—should be sufficient, and that the only addition should be that of a Robinson's Anemometer to the wind vane for the determination of the force of the wind. On the other hand, he should energetically maintain that on the Barometer scale *only* millimètres, and on the Thermometer scale *only* Centigrade (at all events no Reaumur) degrees should be admitted.

Hours of observation.

3. He should stand out for the proposition that, for the normal stations, the hours of observation which are usual in the country (thus, for Switzerland, 7h, 1h, 9h) may be maintained; but that, on the other hand, whether by two-hourly observations or by self-recording apparatus, the elements of reduction must be determined for each country, in order to be able to deduce the true Daily Mean from the mean of the observations. Switzerland has now in Geneva, on the St. Bernard, and on the Simplon, two-hourly observations; in Berne and Zürich complete self-recording apparatus, from which the former are already taken, but the latter at the present date are still in want of the necessary working power. If the International Congress, as possibly may be proposed, should determine to supply at common cost, at a few such mountain points, self-recording apparatus, the Swiss representative has to take measures that, if possible, Switzerland should also obtain such an apparatus, whether it be for an isolated point, as the Rigi Kulm or the Faulhorn, or a high pass like St. Bernard, or even St. Theodule. It is specially desirable, for the measurement of Rain, that it, at least at the central stations, should be taken not only at one hour of observation (1 o'clock), but at every hour, and that the greatest care should be devoted to the determination of the duration of the fall.

Means.

4. He should propose that, for the calculation of the Daily Means, the beginning of the day should be set at midnight, but, for the calculation of the daily fall of Rain, should be set at the noon observing hour. For the calculation of Five-day Means 73 means should be maintained, in opposition to 72, which are also proposed. For the calculation of Seasonal and Annual Means from the Monthly Means, regard must be had to the length of the month. For the commencement of Five-day Means, the beginning of the civil year is to be

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recommended; for the commencement of the Seasonal and Yearly Means, December; but if a general uniformity of commencement should be demanded, it might be voted that it should be postponed to the beginning of March. Suppl. I. Prof. Wolf.

5. He should co-operate in preparing a general scheme for publication for all normal stations. For secondary stations every country retains its own freedom of publication, but the wish should be expressed that in general a form which approaches as nearly as possible that of the normal stations should be chosen.

6. Finally, he should vote for the establishment of an International Central Institute (for instance, in Utrecht), on the idea that each country, in proportion to its population, should bear a share of the cost of the expenses arising from it. It is probable that a sub-committee must be appointed for the discussion of the special arrangements of this Central Institute. International Institute.

II.

Letter from Professor E. Plantamour to Director C. Jelinek, in Vienna. Suppl. II. Prof. Plantamour.

Geneva, August 8, 1873.

I take the liberty to make a proposal to you and the managing committee named in Leipzig, on the order of business, and on the sequence in which the various questions should be taken into consideration by the Congress which is in prospect. The chief object of the Congress is, without doubt, the foundation of an International Central Institute, in which the data which have reference to *Comparative Meteorology*, and which are forwarded from the stations in the various countries, should be collected, sifted (where necessary, converted to the same scale), and published. On this account, it appears to me that the questions which refer to the foundation of such an Institute, and the responsibilities which will fall upon it, should be submitted to the Congress first and before all other subjects. International Institute. pp. 9, 27, 50.

It can scarcely be doubted that the establishment of a Central Institute will be unanimously voted by the Congress, and there will be no difficulty in coming to an agreement with regard to its title. If, moreover, the task which is laid on the Institute by the Congress should be confined to Comparative Meteorology, omitting all questions which have a special local interest, the data which are to be sent in by any one station may be collected into a very small series of numerical values. It is clear that the Central Institute cannot undertake the detailed publication of all the records and observations which form the bases of these data, partly on account of their unmanageable extent, and partly because the objects would be missed, inasmuch as a general view of this ocean of figures would be perfectly impossible.

The demands which should be made to each station for the requirements of Comparative Meteorology would be as follows:—

1. The deviation of the 24 hourly means from the normal values (deduced from many years' means) for Pressure, Temperature, Vapour Tension, Humidity, Wind Direction and Force, Amount of Cloud, Precipitation (quantity and duration). These data might be furnished in the scale or unit of measure which is used in each country, and should be converted at the Central Institute into the units of measure which are adopted by the Congress for publication. In this way one of the most difficult questions, which occupied much time at the Leipzig Conference without being settled, and on which the Vienna Congress will perhaps fail to arrive at a conclusion, may, so to speak, be set aside; at least it would receive quite another meaning, and agreement might easier be expected. If the question which is proposed for the Congress to be discussed at first has reference to the scales or units of measure which are to be adopted, and this question should be so interpreted that every country should have to adopt for the entry of meteorological observations the units fixed by the majority of the Congress (a step which naturally requires a change of all the scales of the instruments wherever a different unit has been used, and brings with it, for data of local interest, a breach of the habits of many years), I fear that an agreement on this question will scarcely be obtained.

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Suppl. II. Prof. Plantamour. International Institute.

If, however, it remains open to every country to hold to the units to which it is accustomed, it will be much easier to come to an agreement on the unit for publication which is adopted by the Central Institution. It is evident that the same unit should be adopted for all stations, and also that the labour which is imposed on the Central Institution will be lessened if that unit is adopted in which the materials sent in from the majority of stations are expressed. This labour would, however, not be too great if we had regard to the comparatively small number of values which would have to be recalculated, and to the means which would have to be placed at the disposal of the Central Institute. The publications of the Utrecht Institute, which are so valuable, and which have been continued for so many years, and which in many respects might serve as a pattern, are a proof of this. But as in any case it would be necessary to effect a copy for the monthly tables, which must be prepared for printing, a conversion into another unit, when properly copious tables are used, would scarcely take a longer time. Further, I think it should be left open to the meteorologists of every country, or to the Central Stations or Institutes which already exist, to retain the system of meteorological observations which they have adopted, whether it be based on self-registering apparatus, or on direct hourly, two-hourly, or three-hourly readings of the instruments, provided that the system is sufficient to show with requisite accuracy in how far each day differs from the normal circumstances at the same epoch of the year, with respect to Pressure, Temperature, Vapour Tension, and Humidity. The wish to introduce absolute uniformity into the observing system at all stations, in all countries, would be extremely difficult, if not impossible, to be carried out, and the following objection could not be overcome, that at certain stations the normal values are calculated from a long series of years, while in others meteorological observations have only been a few years in existence. The greater the independence which is allowed to the local committees, the easier will an understanding be arrived at. At all events, one should not look for absolute completeness in the first publications of the International Institute as far as concerns the uniformity of the data of the various stations. Nevertheless, they would be in a position to give very important information on the subject of Comparative Meteorology; and, besides, we may safely expect that gradual progress will be made towards completeness.

2. In case of unusually great disturbances, of which only few occur in the year, each station should have to furnish, for the few days in question, the *hourly* deviations from the normal values, in order that the Central Institute should be in a position to follow the course of the disturbance by a comparison of the deviations which take place at the same absolute moment.

3. Lastly, each station should send in the mean values, which are to be used for the calculation of the deviations, in any unit of scale which may be preferred, and it should be converted into the adopted unit by the Central Institute and published. Of course this publication cannot be made at the same time for all stations, but must take place gradually, and for this a comparatively very small number of data are sufficient, no matter how large the number of observations on which they are based may be, whether one is content with publishing the formulæ of daily and yearly values, or gives the mean values for a sufficiently large number of epochs, separated by equal intervals.

I believe that the order which I propose for the sequence of the questions laid before Congress would materially contribute to shorten the debates, and would ensure for many of them a satisfactory result, which might otherwise meet with serious obstacles.

III.

LETTER from M. ANTONIO AGUILAR Y VELA, Director of the Astronomical and Meteorological Observatory of Madrid, to the PRESIDENT of the METEOROLOGICAL CONGRESS of VIENNA.

Madrid, 1st September 1873.

WHILE staying at Vienna, as a Juror for the Exhibition, I had the honour of explaining in detail to M. Jelinek my opinion on the different

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points which should be discussed by the learned body of meteorologists assembled in the capital of Austria. I have requested M. Jelinek, who knows my opinions, to represent me at the Congress, as I found it impossible for me to attend it, for reasons which you will perfectly understand, which do not allow me to be absent from the Observatory so long, having been obliged to remain at Vienna six weeks on account of the Exhibition. Suppl. III. M. Aguilar.

I shall confine myself therefore in this letter to condensing my opinions into a very few words, which can be developed by the Director of the Meteorological Observatory of Vienna.

Question 1.* In my opinion this question is completely answered, since the International Geodetical Congress has decided upon the adoption of the decimal Metric system for all nations.

2. The Observatories should all have a mercurial Barometer.

3. This question is very complicated and very difficult to settle definitively. The experiments which doubtless will have been made since the meeting at Leipzig in 1872 will throw much light on the best method of placing the thermometers. At the Madrid Observatory they are in an open space, far from buildings, under a revolving pent-house roof, and protected on all sides from the sun's rays by means of louvre-screens.

4. The maxima and minima thermometers by Casella of London give us excellent results, care being taken, however, to compare them from time to time with the standard thermometer.

5. For the daily observations of Radiation we use the black-bulb maximum thermometer in vacuo, and minimum thermometers placed on the ground and in a parabolic reflector.

6. At the Madrid Observatory we have five thermometers, placed at depths of 2 ft., 3·9 ft., 5·9 ft., 9·8 ft., and 12·2 ft. I am not acquainted with the management of Becquerel's thermometer.

7. The psychrometer in preference to the hair-hygrometer. In Spain we have less than anywhere else to fear from the irregularities of the psychrometer, when the temperature sinks below zero, because that rarely occurs.

8. In Observatories which have apparatus to record observations in a continuous manner the matter is very simple, but for stations of the second order the eight principal points are sufficient.

9. Our stations of the second order use only the scale 0–4. 0 indicates Calm, and 4 a violent wind.

10. We have begun to introduce Robinson's anemometer with the metric scale at our stations of the second order, for determining the velocity of the wind.

11. At the Madrid Observatory this observation is made every three hours at the same time as the others. At stations of the second order it is made at 9 o'clock in the morning.

12. Without doubt days of Rain and Snow should be distinguished, and the quantity of water which falls under these two forms.

13. It would be desirable to do so, but very difficult to obtain it at stations of the second order.

14. Days of thunderstorm must be distinguished from the number of storms, and account must be taken of sheet-lightning, but these observations also are very difficult at stations of the second order.

15. Evaporation should be observed in a vessel exposed to the free air and to the sun, placed in identical conditions at all Observatories, according to the decisions of the Congress.

16. The amount of cloud should be estimated by the scale 0–10. 0 indicates clear sky and 10 overcast.

17. It is very difficult to introduce everywhere electrical observations, as they require altogether special conditions in the Observatories. It would be very useful if they could be instituted at central Observatories.

18. It is very difficult to satisfy this want without having self-recording instruments, owing to the very inconvenient hours which would result, especially for western countries.

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* The numbers of the questions refer here to the programme settled by the Meteorological Conference of Leipzig.

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Suppl. III. M. Aguilar.

19. Very desirable, and inspection is necessary in order that the observations may be subjected to the check which is indispensable. My opinion is that the observations should be few in number, but that all measures possible should be adopted to ensure their accuracy.

20. It is immaterial whether the meteorological year begins with December or January. We shall follow the decision of the Congress. Means should be taken for Days, Decades, Months, and Years, without introducing Five-day periods, which I do not think important, regard being had to the labour they entail.

21. The normal values should be deduced from the greatest possible number of observations.

22. The desirability is evident. The rules which will be established by the Congress for settling the question should be followed with the greatest exactitude.

23. By the measures which the Meteorological Congress will adopt, and the sanction which the respective Governments represented will give, by giving all means necessary for carrying it out.

24. The reply to this question can only be in the affirmative. Otherwise the establishment which should centralize the works of the different countries cannot attain its object.

25. The utility is incontestable; the difficulty consists in the realization of this project. In calm weather the despatches arrive with great regularity, but when a storm is announced, they arrive very irregularly, precisely when they are most important. The support of all the telegraphic administrations is necessary, and therefore I think that at present we must not complicate matters by requiring too much work, but, on the contrary, limit ourselves to that which is absolutely necessary. A few points of observation, suitably chosen in each country, and embracing the greatest possible surface of the globe will, doubtless, give excellent results.

26. The approval by the different Governments of the decisions of the Congress, the institution of a Central Office to watch over the carrying out of these decisions, the assembling of the Congress at least every three years in a central country to discuss, and, if necessary, to modify the previous decisions according to the results of experience, and the new arrangements to be proposed in order to improve the system established, will be, in my opinion, the points to be settled at the Congress at Vienna.

One of the greatest difficulties in suitably establishing the meteorological service is without doubt the securing observers for stations of the second order, badly or not at all remunerated. Every possible effort must therefore be made to give a little more stability to this staff, and no means are more certain of succeeding, than by giving them salaries proportional to the responsibility which is required of them. As this staff may be attached to other services, such as Public Instruction, Telegraph Stations, &c., according to the country, a small remuneration might suffice.

It only remains for me to assure you, Sir, that I shall do all in my power to induce the Spanish Government to accept in all particulars the decisions of an international character which will be taken by the Congress, and as to the other decisions, the carrying out of which may be decided by myself, you may rely on my following them with the greatest exactitude, according to the means at my disposal.

Accept, sir, &c.,
ANTONIO AGUILAR.

IV.

METEOROLOGICAL SOCIETY.

30, George Street, Westminster, S.W.
June 16th, 1873.

SIR,

IN pursuance of a resolution of the meeting of this society held on 21st of May, I have to forward you a copy of the discussion upon some of the questions submitted to the Leipzig Conference, and to request that you will,

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upon the form below, favour the Council with your opinions thereupon. Your reply will be materially facilitated by previous perusal of the discussion.

Please answer this on or before June 30th.

I am, sir, your obedient servant,

WILLIAM MARRIOTT,
Assistant Secretary.

Questions.

No. 2. What is the best form of barometer for stations of the second order? Is the use of an aneroid for such stations admissible as an independent instrument or otherwise?

No. 4. What is the best construction of maximum and of minimum thermometers?

No. 5. What instruments should be employed for determining the intensity of solar radiation, and in what way can the comparability of the results obtained be ensured?

No. 18. Can uniform times of observation be introdueed, and if so at what hours, say 9 a.m. and 9 p.m.? Do you consider that local or Greenwich mean time (railway time) should be adopted?

No. 20. What divisions of the year are the best for the calculation of mean results? Do you think that one day should be subtracted from January and from March, and added to February, so as to make up that month to 30 days?

Report on the Replies received in answer to the Questions issued with the Circular of June 16th.

No less than 52 of the Fellows have favoured the society with their opinions on the various points under discussion, and in addition communications have been received from Professor Buys Ballot and from Mr. Plummer of the Durham Observatory. In several cases the questions have not been answered directly, more than one answer having been given; in all such instances the author has been taken as adhering simply to the solution for which he expresses his preference.

We shall now proceed to an analysis of the replies, but it must be remembered that in many instances the writers have only answered the questions relating to the subjects with which they were specially familiar, so that a simple comparison of the number of votes would be fallacious.

Barometers. The replies regarding the best form of Barometer were 46, with a very decided opinion in favour of the Kew barometer, 33 gentlemen recommending it, while the remaining 13 mostly supported the use of Fortins' Standard.

Aneroids. On the subject of the utility of Aneroids opinions were more divided; out of 47 votes 22 were decidedly unfavourable to their use, 19 suggested their employment as auxiliary instruments, while only six were for their general admissibility.

Maximum Thermometers. The choice of Maximum Thermometers was limited to Negretti and Zambra's and Phillips'. It is not easy to give a precise analysis of the views entertained. 32 Fellows wrote in favour of Negretti's and 17 in favour of Phillips', but several replies suggested that both instruments might be used; 42 answers were received.

Minimum Thermometers. As to Minimum Thermometers the sense of the society was nearly unanimously in favour of Rutherford's spirit minimum, 40 out of 42 replies taking that line; a few gentlemen also recommended the use of Casella's mercurial minimum, if sufficient precautions were taken in its management.

Radiation. For Solar Radiation 25 votes out of 28 were for the black bulb *in vacuo*, dull black extending one inch along the stem. No suggestions of much importance were made as to ensuring the comparability of results, but a wish for the adoption of 4 feet above the ground as the height of exposure, was expressed by 12 gentlemen.

Hours of Observation. On the important subject of Hours of Observation, the unanimity in favour of 9 a.m. and 9 p.m. was very great, 41 out of 50 of the fellows expressing their

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Suppl. IV. Meteorological Society. Hours of Observation.

approval of those hours. Some few proposed the addition of an 8 a.m. observation to work up with the Telegraphic Reports.

As might be expected the question of local *versus* Greenwich time elicited a difference of opinion; 48 answers came in, which were divided into 30 for local, 16 for Greenwich time, while two made special propositions.

No very decided wish about the division of the year was elicited, 38 gentlemen expressed their opinions, but most of them voted for several classes of means.

11 simply wished the civil divisions of the year to be kept,
22 asked for monthly means,
7 „ weekly means,
12 „ five-day means (mostly Buys Ballot's,)
6 „ seasonal means,

and a few mentioned daily means.

The sense of the society is rather decidedly against any alteration in the length of February; out of 42 answers 27 being unfavourable and 15 favourable.

The remarks of Messrs. Birt and Bloxam on uniformity in hours of observation deserve attention. Mr. Forbes gives a good table of corrections for the 9 a.m. and 9 p.m. readings for the north of Scotland.

Mr. Rundell and also Mr. Plummer make suggestions for artificial divisions of the year.

Professor Buys Ballot has honoured the society by again putting forward in his reply to their circular some of the views which he has already advanced in his valuable "Suggestions on a Uniform System of Meteorological Observations."

On the whole the Form Committee cannot but congratulate the council on having elicited such an extensive expression of opinion on the various points contained in the circular.

Appendix to Report.

The remarks of Mr. Birt are as follows:—"It appears to me that the first element of usefulness in a series of observations is the object the observer has in view. There are two distinct objects which meteorologists may recognize. First, climatic relations (having reference to time only) which must be deduced from observations made at stations where observers reside, and for such observations the hours of 9 a.m. and 9 p.m. (to the minute) are the most suitable, and these, of course, to be of any value, must be *local* mean time. Second, the progression of the two principal meteorological elements, temperature and pressure, having reference to space as well as time. If the observer be interested in these progressions and makes choice of working in concert with the Meteorological Office his hour of observation is 8 a.m. *Greenwich* mean time (also to the minute). A system of three daily intervals of eight hours each would greatly facilitate the study of the great movements of the atmosphere; the hours of observation being 8 a.m., 4 p.m., and 12 p.m."

Mr. Bloxam writes as follows:—"It appears to me that if the observations of many persons are to be used for the purpose of deducing laws in the science of Meteorology, it is of the greatest importance that "uniform times of observation" should be adhered to. The system of simultaneous observation is incompatible with uniformity in the ordinary work of meteorological observation, and in my view the use of local time is indispensable. I believe 12 o'clock, noon, to be the best hour for observing and recording the ordinary meteorological phenomena. I believe this to be the best hour, because the sun's influence upon temperature must, as a rule, be more uniform as regards diurnal progression at different stations at this hour than at any other between his rising and setting, and tables for diurnal range will apply more correctly to all stations for this hour than for others. The diurnal progression of temperature is different on an elevated situation from what it is in a valley. . . Of course it is very desirable that the convenience of the observers should be consulted, and if another hour would be more convenient generally, it might be better to select another hour for general use, but 12 o'clock observations would then be available if made in addition to the other or others."

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V.

On the Exposure of Thermometers for the Calculation of Air-Temperature.—By H. Wild.

Report to the first sub-committee appointed to discuss Questions 2–6 of the programme.

The investigations which I have originated at the Central Physical Observatory at St. Petersburgh, in order to determine the influence of the exposure of thermometers on their indications, were carried out in three directions. Firstly, the action of screens to prevent the disturbing action of Radiation towards surrounding bodies was examined, then the effect of rapid movement as well of the Thermometer itself, as of the air which surrounds it, in reducing the effect of Radiation, was determined, and finally the influence of the height of the thermometer above the ground on its indication was strictly inquired into. As these investigations are not yet quite complete, I can only here communicate a few preliminary results to which they have hitherto led me.

1. Influence of the Screen. It may at the present moment be considered as universally admitted that thermometers which are put up without a screen, on a window or anywhere else on buildings, or are even exposed perfectly freely, do not give the true temperature of the air at the place in question, but give something intermediate between that temperature and that of the surrounding objects which radiate towards the thermometer, so that it seems superfluous at this place to waste any words against the free exposure of thermometers. In the March number of Symons' Monthly Meteorological Magazine for 1869, among the Strathfield Turgiss experiments on comparative exposures of thermometers, one with an unprotected bulb was mentioned, the thermometer being suspended quite freely 13 feet above the ground, on a wire stretched between two posts. According to Glaisher* a thermometer so exposed, even in strong sunshine, should give the temperature of the air much more accurately than any other one suspended nearer to the ground, or in the shade of houses. An assertion expressed so positively in the Philosophical Transactions seemed to call for a corresponding experiment. In an open space, far from any buildings, I suspended a thermometer by means of a cord on a telegraph wire stretched between two telegraph posts, 66 feet apart, in such a way that its bulb was 13 English feet above the grass. The instrument was read at the same time with the thermometers erected in the shade and protected according to my method, at times from below and from a distance with a telescope, at times by bringing a ladder which was mounted quickly.

Exposure of Thermometers.

My own readings as well as those of the other observers of the Observatory, gave, between 7 and 1 o'clock in sunshine a temperature about 5°·0 F. higher for the open thermometer than that in the shade; at 9h p.m. if the sky was clear, a temperature to the same extent lower than it. I think this is sufficient to do away with thermometers suspended freely at a height of 13 feet, and the more so because the assertion of Mr. Glaisher is chiefly based on the comparison with a thermometer which is erected in his thermometer screen 4 feet above the ground, and thereby in his opinion is completely protected against Radiation. This, however, as we shall see later, and as has been already stated on other authority, is distinctly not the case.

Passing to the consideration of *protection*, I cannot suppress the remark that here, as often in Meteorology, the simplest physical laws have been transgressed. It was thought that the thermometers were sufficiently protected against Radiation when they were enclosed in *wooden boxes*, which were at times half open, at times enclosed on all sides, except the bottom, by louvre boarding, and for the most part were very small. If the physicist, in experiments on radiant heat, wishes to stop the radiation of any warm body towards the thermoscope he generally uses a single or double screen of thin sheet metal. It is in my opinion not merely considerations for the elegance of the experiment which determine him to choose this material instead of a wooden board, which is equally athermanous. At the place where the rays of heat strike the screen and are absorbed by it, the temperature of the metal, in consequence of its low

* Philosophical Transactions for 1847. Part I. pp. 124 and 142.

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Suppl. V. Prof. Wild. Exposure of Thermometers.

specific heat, will be raised at the first moment, somewhat more than that of the wood, but on account of the much higher conductivity of the former, the heat will be conducted equally on all sides in the sheet, and restored again to the surrounding air; while in the wooden board it remains more concentrated, and so gradually a great rise of temperature can take place at the point in question which subsequently can only disappear slowly. In a few words the thin sheet of metal places itself much more rapidly in thermic equilibrium with the surrounding air than the wooden board, and is therefore much better adapted for preventing Radiation.

By such considerations I was induced, as long ago as the year 1860, to introduce, as a protection for thermometers in the meteorological stations which had been newly erected in the Canton Berne, cylindrical *screens of thin sheet zinc*, open below and enclosed above by a conical roof.* In order to ensure the free access of the air to the thermometers and to prevent its stagnation in the screen, the sides were not continuous, *i.e.* they were formed of segments of 12–13·5 in. diameter, which were separated by open spaces, and so arranged that to every opening in the inner cylinder a portion of the outer cylinder corresponded and *vice versâ*. The walls of the cylinder, which were about 16 ins. in height, are separated from the roof, which overhangs them slightly, by the space of 0·8 in., so that you can see freely under the eave of the roof; and similarly the conical roof consists of two portions, one above the other, and separated by a similar distance. One of the outer segments is fitted up as a door, for observing the enclosed thermometers. If this screen could be erected on the north wall of a house, it was suspended on hinges before a window by two iron rods 14 ins. in length, which are fastened to its sides, so that it could be drawn, for the purpose of reading the thermometers, towards the window, while otherwise it is kept standing at a distance straight out from the house. Where this was not possible, as, for instance, at the Observatory at Berne, the metal screen was erected, for protection against the sun's rays at noon, in a wooden box supported by two poles, quite open on the north side and below, and with two walls above and on the south side, at a distance of about 1 foot from the screen. Similar screens were introduced in the year 1863 at all the newly-founded meteorological stations in Switzerland. Similarly, at my proposal, in the Instructions for meteorological stations in Russia, published in the year 1869 by the Academy of Sciences of St. Petersburg, a thermometer screen arranged according to the same principles has been adopted.† The only difference is that the sheet-zinc screen is rectangular, the sides are louvred, with horizontal openings, and, in order to prevent birds getting in, the bottom is formed of wire net. This is erected with its side walls attached to two wooden supports, which are either placed before a north window of a house, or are better erected in a wooden house standing quite free to the north and quite open below. The lateral walls of the wooden house are also louvred, the south wall and the roof are massive and double.

By repeated special experiments, which are partly contained in the above quoted paper in the Bernese *Mittheilungen*, I have convinced myself that the temperature of the walls of such a metal screen may be 3°·5 different from that of the air, without its altering by radiation the temperature of the enclosed thermometers to the extent of two tenths of a degree F., owing to the motion of the air within the screen which is immediately produced; similarly the ground under the screen may have a temperature 36° higher than the air, before it warms by radiation to the extent of 0°·2 the thermometer, which is placed about 10 feet above it. The influences of Radiation which, in their direct action on the thermometer, do not exceed 3°·5 are thus, by means of protecting metal screens, eliminated entirely, to the extent of the usually adopted limit of error of observations for temperature of $\pm$ 0°·2. In the erection of the metal screens on the north side of a house in the mean latitudes simply, and in higher latitudes with the addition of a wooden or linen screen at the distance of one foot on the east and west sides, or in a wooden house which stands perfectly open, of the nature described, no influences of Radiation exceeding 3°·5 in their effects are to be feared, and it is as little to be expected,

* H. Wild, on the Calculation of Air Temperature. II., Exposure of the Thermometer at the ordinary Meteorological Stations. Mittheilungen der Naturforschenden Gesellschaft in Bern. 1860, p. 108.

† Instruction for Meteorological Stations, by H. Wild. Repertorium für Meteorologie. Vol. I. p. 96. And Additions to these Instructions. Ibid, Vol. II. p. 4.

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considering the small mass and the good conductivity of the metal sides that, even in rapid variations of air temperature, the temperature of the metal walls will differ more than 3°·5 from it. If then the openings in the metal screens are arranged in such a way that the air cannot stagnate within, it is more than probable that by this mode of screen the true temperature of the air can be obtained. That this method protects the thermometers as well from Rain as from Radiation scarcely needs to be mentioned.

To employ wooden screens alone for the protection of the thermometers, in my opinion, should be entirely rejected, in consequence of their great mass and bad conducting power, and I therefore think that not one of all the thermometer screens which were used in the Strathfield Turgiss experiments* is suited to give the true temperature of the air. Of old thermometer screens, as far as I know, it is only Kreil, at the Austrian stations,† and Kupffer at the Russian, which have used them of metal. The first of these, however, seems to me not to afford sufficient protection against Radiation or Rain, while the latter represents a case of metal and glass, almost hermetically closed, with the exception of a few openings at the bottom, and accordingly the exchange of the air between the inside and outside is much too limited.

Comparative observations which I have already made in Berne showed me that if thermometers be placed in various points in such metal screens, they scarcely differ $\pm 0°·4$ in their simultaneous indications, while thermometers exposed perfectly open, close to the screens, give differences of $\pm 1°·1$ and more.‡ Observations in the same direction which have been instituted at St. Petersburg, more when occasion offered than systematically, have given similar results.

From February to May, and in June and July of this year, I have further instituted, in a large wooden hut at our magnetical observatory, which has been built according to the above-named principles, comparative observations of the simultaneous indications of thermometers enclosed in the metal screen and of one suspended freely near it. The most decided result of these observations which has hitherto been obtained seems to be that the difference of the extremes of the open thermometer in the winter was 0°·5, and in summer as much as 1°·3 less than of that enclosed in the screen, and in the case of sudden oscillations of the temperature, the open thermometer was behind that in the metal screen. This, if it were confirmed by more complete observations in this direction, would unmistakeably prove the disturbing influences of badly-conducting simple wooden houses. The same effect is indicated further by the circumstance that in summer the mean temperature of the enclosed thermometers, was on the average 0°·4 less than that of the open one, and consequently agreed much better with that which was erected in the open and airy hut in the second court and was also enclosed in a metal screen.

In the year 1869, on the other hand, comparisons with thermometers, of which some were erected in an open metal house on the N.N.W. side of the magnetical observatory 8 feet above the ground, and the others 4 feet above the ground in the well-known Glaisher's stand, gave for the latter an amplitude of the daily variations of temperature in summer, which was on the average 1°·8 greater, a result unmistakeably attributable to the Radiation from the soil, and from the portion of the sky which was opposite to the sun, against which no protection was afforded.

Finally, I have to enumerate experiments to protect the thermometers, even against the direct rays of the sun, by surrounding them with four concentric metal cylinders and double cones, the openings of which alternate with each other. These have as yet only led to negative results.

2. *Influence of motion.*—Experiments in this direction have been as yet conducted on two principles; firstly according to the proposal of Dr. Rühlmann at the Meteorological Conference in Leipzig, similar thermometers were fastened with corks into brass cases, with double walls, and closed all but a few small openings. Both of them were erected in a wooden hut in the magnetical observatory, close to each other, and by means of centrifugal bellows during the observation a current of air was driven through one while the other remained at rest. In the months February to May, on the average, the thermometers placed in the air current gave a temperature 0°·2, but in the maximum 0°·7 higher; in July the differences were still less.

* Symons' Monthly Meteorological Magazine, April, 1869.
† Jelinek, Anleitung zur Anstellung Meteorologischen Beobachtungen, Vienna, 1869, p. 40.
‡ l.c. pp. 116, 118.

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Suppl. V. Prof. Wild. Exposure of Thermometers.

Then a psychrometer with thermometers placed in a slanting direction, and leaning outwards, and movable round a vertical axis passing through the middle was erected in the same hut, near the metal house. Every time after the reading of the thermometers in the latter, the readings of these thermometers were noted, first in a position of rest, and then twice after a *rapid rotation* round a vertical axis on each occasion. This may represent a sort of *thermomètre fronde* which is swung in the shade.

The observations instituted at the end of June and beginning of July, gave for the free thermometer on the mean, in the first position of rest, a temperature higher by 0°·12 than that enclosed in the screen and this difference contrary to expectation, still further rose on rotation, so that after the first rotation it was 0°·18, and after the second 0°·34 higher.

Further experiments will show whether the elevations of the temperature observed in both these cases, are really to be attributed, as seems to be the case, to the heating of the air by compression or friction.

3. *Influence of height.*—The observations hitherto instituted on the influence of small heights, *i.e.*, up to 30 metres (100 feet) above the ground, on the temperature of the air, seem almost without exception to have this defect; that from the mode of exposure which has been employed for them, it is uncertain whether the differences of temperature which have been found are not altogether, or at least partly, to be attributed to differences arising from radiation, and not to differences of height. The observatory at Pulkowa possesses a geodetical signal scaffolding 24·7 metres, or 81 feet high, standing in an open field, is of timber lightly put together, and its storeys are very well suited for the erection and exposure of thermometers at various heights, under exactly similar conditions. M. O. v. Struve, Director of Pulkowa Observatory, kindly allowed me to use this scaffolding for such observations. By the kind assistance of M. Block, Assistant in the Observatory, I had three psychrometers with minimum thermometers in metal screens, with outside wooden cases, of the nature above described, erected on the scaffolding at various heights. The first is 6 feet above the ground, the second 52 feet, and the third 86 feet. M. Schwarz undertook the observations himself even in the winter, once a day, at 1 o'clock, and at the other seasons three times, viz., at 7 h. or 8 h. a.m., and 1 h. and 8 h. p.m. They began on the 15th Septr. 1872, and extend now almost over a year.

These observations, thanks to the similarly exposed thermometers, which exclude the effect of radiation, indicate on the average a much less influence of height on the temperature, than the analogous observations of other investigators in general. The mean values of the temperatures at the different heights only differ about 0°·2 in the summer as well as in the winter months. It must be admitted that at the individual hours of observation on the average the upper thermometers read lower in the morning and higher in the evening than the lower thermometers; but the differences between the highest and lowest, on the mean is only 0°·9 and on the whole year they only amounted to 3°·5 or 4°·5 a few times.

From this it appears that for the exposure of thermometers for the determination of the temperature of the air near the surface of the ground, if they are sufficiently protected, their height above the ground need not necessarily be the same, but may vary very well between 6·5 and 33 feet without having to fear greater differences in the indications than will be found in exposures at somewhat different points on the same horizontal plane.

VI.

LETTER from PROFESSOR J. CANTONI, Delegate for the Ministry of Agriculture of Italy to the METEOROLOGICAL CONGRESS of VIENNA.

Considerations and experiments on Questions 2, 4, 5, and 6 of the Programme.*

2. What mode of exposure of Thermometers for the observation of Air Temperature is the best and most suitable for general adoption

When in 1860 I undertook a series of Meteorological Observations at the University of Pavia, I occupied myself first of all with making experiments on

* The Nos. of the Questions refer to the Programme of the Vienna Congress.

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the most suitable form for and exposure of the thermometer in order to determine the temperature of the air at a given moment.

Professor Belli, my predecessor, had already set forth the difficulties of this investigation. Several mercurial thermometers whose scales had been previously compared carefully with each other, being exposed together in the same place in the open air, and read at the same time, gave very different indications, when the form, capacity, and thickness of their bulbs were not exactly similar; that is, they showed with a different degree of sensitiveness the influence of the variations which took place in the temperature of the air. The spherical form, *cæteris paribus*, is the least suitable in this respect, and the cylindrical form is the best, provided that the diameter be small enough with respect to the length. Of course the sides of the bulb should be very thin, as it is made by blowing the bulb of the same material as the stem. Then different thermometers with cylindrical bulbs give very nearly the same readings of the temperature of the air, although the dimensions of the respective bulbs differ somewhat from each other. But these differences will diminish much more and will become almost inappreciable if, by some artifice, a rapid motion be produced in the air of which we wish to determine the temperature. And, particularly, for Meteorological Observations the thermometers must be well protected against the thermic radiations of adjacent bodies, and the air must be allowed rapid circulation round the bulb.

To attain the first of these ends, I have first of all made attempts to silver the thermometric bulbs by the cold process; but I found it very difficult to obtain a metallic deposit sufficiently thin and polished on its exterior surface to ensure securing the maximum reflecting power. Moreover, at certain seasons of the year, we cannot prevent the thermometer, although exposed to the north, from being struck by the direct rays of the sun. Then I tried to protect the instrument by a double cylindrical brass tube, whose axis coincided with that of the bulb, and whose height was at least four times that of the bulb itself; the inner tube had a diameter of at least 2 ins., and the outer one of more than 3 ins.; they were open at top and bottom, so that the air could circulate freely all round the bulb and between the two tubes. But although their thickness was very small, I perceived a sensible influence exerted by radiation and by the circumstance of the screens communicating their own heat to the air.

It is well known that by swinging the thermometer rapidly round in the air, the influence of radiation on it is much reduced; so that, by this means, we may attain the two ends above mentioned at the same time and reduce to a minimum the influence of the different dimensions of the bulbs. But instead of swinging the instrument, which is dangerous and makes the reading difficult, I preferred to give a rapid movement to the air surrounding the bulb by means of a small wheel, as I shall afterwards explain, when speaking of the psychrometer.

As to the other question, that of the best exposure of the thermometer, we must first of all decide whether the thermometrical observations are for the purposes of Agriculture and Sanitary Science, or only for Meteorology, properly so called. In the former case it is well known that the thermometer should not be placed on the top of a tower or large building, but in a garden, or, better, in an open field, at a little height (one or two yards) over a soil covered with grass, and sheltered by a suitable roof, so arranged that the instrument should never be struck by the sun's rays, and that the air should circulate round it freely. M. Charles Martins, at Montpellier, and many other meteorologists have shown that, for a given locality, the differences of the results between these two modes of exposure are considerable. I resolved to determine them under the conditions afforded by the town of Pavia (latitude, 45° 11″). We compared, during four years, the march of maximum and minimum instruments, some of them being exposed outside a window to the north of the tower of the meteorological observatory of the University, at the height of 66 feet above the court, and others in the botanical garden, at the height of 5 feet above the cultivated soil, and protected to the north by an enclosing wall 11 feet high. Both were equally protected against radiation by a metal screen which surrounded them, while leaving the movement of the air free above and below; and, moreover, the bulbs of all the thermographs were gilded on their exterior surface, and were cylindrical in form, with a vertical axis, and none of them were in contact with the scale.

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Suppl. VI.
Prof. Cantoni.
Exposure of Thermometers.

—	Means.				
	Winter.	Spring.	Summer.	Autumn.	Year.
	°	°	°	°	°
Means of the daily maxima:					
Botanical garden - -	48·52	70·38	89·22	69·71	69·46
University tower - -	43·90	64·17	83·77	63·54	63·85
Differences - -	+4·62	6·21	5·45	6·17	5·61
Means of the daily minima:					
Garden - -	27·93	44·73	60·69	46·78	45·03
Tower - - -	29·86	46·69	62·82	48·16	46·88
Differences - -	−1·93	−1·96	−2·13	−1·38	−1·85
Means of the daily extremes:					
Garden - - -	38·23	57·56	74·97	57·90	57·25
Tower - - -	36·86	55·42	73·29	55·85	55·36
Differences - -	+1·37	2·14	1·68	2·05	1·89
Mean range of the daily extremes:					
Garden - - -	52·59	57·64	60·53	54·95	56·43
Tower - - -	46·04	49·48	52·95	47·37	48·96
Differences - -	+8·55	8·16	7·58	7·58	7·47

It is seen from these numbers, which differ from each other considerably, that the characteristic data of the climate, that is, the mean temperatures of each season of the year, and still more the mean variations of the extreme temperatures, differ greatly with the height. The maxima are always higher in the garden than on the tower, and, on the contrary, the minima are lower; the diurnal variations of the temperature are much greater in the garden than on the tower. Hence the importance of determining well the conditions of the exposure of the Thermometers.

On Question 3 :—

Maximum and Minimum Thermometers.

What are the best Maximum and Minimum Thermometers?

It may be observed, first of all, that these instruments, as to their construction, should satisfy, much more closely than in the case of ordinary thermometers, the conditions of quickness in their indications, so that they may give the extreme temperatures, the highest and lowest, which occur during the day. For this purpose, their bulbs should be cylindrical, and their length many times greater than their diameter, and the axis vertical, in order to facilitate the continual renewal of the air over their whole surface. Further, it is necessary that the glass of the bulb should be very thin, and that the bulb itself should not touch any part of the scale. But, in reality, these conditions cannot be carried out in the registering thermometers, because the tube, in order to contain an index, cannot be so fine as in ordinary thermometers, and therefore it is necessary that the bulb should contain a considerable quantity of liquid. Nevertheless we must endeavour to realise as nearly as possible the above conditions as to quickness of indication. Instead of that, the registering thermometers used at many meteorological stations are not very sensitive. For instance, Mr. Casella's instrument, besides the defects inherent to the union of the two scales by means of a long column of mercury, has a bulb whose form and position on a slab, covered by a little metal shield, is the least suitable for a complete and rapid circulation of the air round it. At most of the Italian meteorological stations the two instruments are separated. The maximum thermometer is mercurial, with the column easily separable by a contraction of the glass in the bend of the tube, and the minimum is of amyl alcohol, which is very slightly vaporisable, as its boiling point is much higher than that of ethyl alcohol, generally used for minimum instruments. In both the bulb is cylindrical, with the axis at right angles to that of the tube, and with

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diameter small in proportion to its length. At some stations the registering thermometer of M. Marchi, of Florence, has been used for several years, which possesses the advantage of having mercury as the thermometric liquid even for the minimum, and of the two scales for maximum and minimum being united in the same tube by means of a liquid not easily vaporized, which contains the two indices (see the description given by M. Donati); but it is necessary to modify its form by making its bulb vertical and also isolated. Suppl. V. Prof. Cantoni.

On Question 4:—

What instruments should be employed for determining the intensity of Radiation, and in what way can the comparability of the results obtained be ensured? Radiation.

I cannot reply by quoting any direct personal experiments, but I shall nevertheless express my conviction that the black bulb thermometer *in vacuo* is the only one that can give mutually comparable results, if it be a question of a determinate instrument always exposed in the same conditions; on the contrary, the results will be no longer comparable if there be the least difference in the conditions of construction and exposure of the different instruments. Nevertheless, this kind of instrument may serve well for certain investigations into the influence of solar light on vegetation; but with regard to this I would recommend meteorologists to try to perfect a very ingenious instrument by Canon Bellani, called the *Caloric Collector*, the principle of which seems to me susceptible of useful applications. Two hollow globes of very thin glass, one black and the other transparent, are united by a tube which is not too fine, and contain a quantity of water, the volume of which corresponds to a little more than half the capacity of the globes, but they are otherwise void of air. Before taking an observation, the water is made to descend into the black globe: the instrument is then re-adjusted, and exposed to the open air and to the sun. Then the black globe getting hotter than the other, the vapours become condensed in the latter and continue to liquefy in a quantity proportional to the successive values of the solar radiation, so that the volume of water which, in a given time, is condensed in the transparent globe, and is collected in a graduated tube attached below it, should be proportional to the sum of all the differences in the heating of these two globes which will have occurred at the different times of the day, and therefore to the successive values of the relative clearness of the day and of the elevation of the sun above the horizon of the place. On an overcast day this complex work of evaporation and condensation will be very small in comparison with that which will be produced on a continuously clear day. This element will have some importance for agriculturists, perhaps greater than that of a few observations made at a given instant by an ordinary black bulb thermometer, as I have stated above. I propose to make further experiments upon this subject.

As to Question 5:—

What apparatus is the best for determining Earth Temperatures? At what depth should the observations be taken in order to attain the uniformity which is desirable? Earth Temperatures.

I think it proper to remark, that, according to a long series of experiments made in the years 1865–6 by my brother, Professor Cajetan Cantoni, when he was director of an experimental institute of agriculture, it is very important for the different kinds of crops, and for the different natures of arable soil to observe the temperatures of the soil by several thermometers, the middle of the bulbs of which are placed respectively at depths varying by 4 inches from 4 to 20 inches. To give an idea of the amount of the first of these influences I shall limit myself to quoting one example. A thermometer placed in the soil of a rice field at 13 inches below the level of the covering of water which is kept over it during the months of July and August, presented very small variations of temperature; for the fluctuation in the course of a day (day and night) kept on an average between 0°·9 and 1°, as well when the day was clear and the air much agitated by the wind, as when the day was calm and overcast; that is to say, that the cooling produced by evaporation in this thin bed of water which covered the soil was almost completely proportionate at

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Suppl. V. Prof. Cantoni. Earth Temperature.

every moment to the heat received from the sun according to his different elevations above the horizon and to the different degrees of clearness and movement of the atmosphere. And the mean daily temperature of this soil, so covered by water, remained at more than 10° lower than that of the surrounding air. Matters were very different in cultivated land, only watered occasionally or not at all.

Observations made at depths greater than 3 feet have but little interest for agriculture, and can only be useful for investigations of terrestrial physics or of geology on the different thermic conductibility of the various soils and various rocks.

As to the first part of Question 6 :—

Hygrometers.

What apparatus should be employed for the determination of the Hygrometric condition of the air?

Disregarding chemical hygrometers and condensation hygrometers, which are inconvenient to use, although theoretically preferable, I shall limit myself to saying a few words on psychrometers, such as are adopted at a greater number of meteorological stations in Italy.

In treating of the 2nd question, I have already referred to the experiments of Professor Belli and myself on the utility of the agitation of the air for rendering comparable thermometers whose indications have a different degree of sensitiveness. Well, this artifice shows itself to be still more useful, and I will add even necessary, for diminishing the appreciable differences of the indications given by these same thermometers, when their bulbs are moistened. It is known that August's theoretical formula for the psychrometer supposes that the layer of air which, by contact with the covering of water upon the bulb of a thermometer, charges itself with vapour, is renewed at every moment, that is to say, with extreme quickness. Thus Professor Belli showed that bulbs of a spherical shape were less convenient for that purpose, because the differences obtained, even with the agitation of the air, in several thermometers with bulbs of different diameter, were much greater than those given by other thermometers, with a cylindrical bulb, of various dimensions, although they were all similarly plunged in the same mass of air, and the differences of these last thermometers became very small when the motion excited in the air was increased by a continuous current by means of bellows or by an aspirator. These experiments, which I have myself continued and varied in several ways, have convinced me that we could give to the psychrometers a sufficient comparability and make them serve at the same time, as I have stated with respect to Question 2, to determine the temperature of the air in good conditions. I have compared under different circumstances the data for psychrometers with those of an excellent condensation hygrometer by Belli, and even with those of a chemical hygrometer by Brunner, and I have found that, by a rapid circulation produced by a pallet-wheel, we find a constant value for the coefficient to be introduced into Regnault's psychrometrical formula for calculating the real tension of aqueous vapour disseminated in the air and the relative humidity of this air; and that, on the contrary, it was necessary to adopt for that purpose different coefficients if the psychrometer was observed without any movement of the air.

VII.

Remarks by G. T. Kingston, Superintendent of the Meteorological Department of Canada, on Two of the Questions brought forward at the Conference at Leipzig in 1872.

Exposure of Thermometers.

I think that before Meteorologists take up the question of the mode of exposing thermometers, they should settle once and for all what the height of the stratum of air is to be whose general temperature near the station observers should endeavour to discover at a proposed instant.

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In choosing a level we have to consider—

1st. What the level is whose temperature, irrespective of convenience and facility in determining it, we most *desire* to know, and—

2nd. What the level is, the knowledge of whose temperature is most *attainable*, either on account of the physical circumstances of the air at that level, or on account of convenience and accessibility.

As regards desirability, a level chosen with reference to animal and vegetable life would be 4 to 5 feet or less; one where changes of temperature are most influential in a meteorological sense, would be much higher.

Apart from considerations of *convenience* the temperature of air at a high level is more attainable than at a low level, because at a high level the temperature is less affected by the more minute accidents of locality, a change produced by passing from level to level or from point to point in the same level, is more slow, and if a thermometer be placed at random in any part of such a stratum the air in contact with the thermometer is more likely to be a fair average sample of the air at that level, than if a lower level had been chosen. With reference to convenience of access, the question should not be complicated by considerations as to the probable height of windows, because windows and indeed positions generally near to large buildings should be avoided.

A fair compromise would be to place the bulbs at some uniform height between 4 and 10 feet, or rather to recommend such a height for universal adoption, since in many cases the adherence to any standard height will be impracticable.

At a height lower than 4 feet the air is liable to be affected too much by local accidents, and a higher level than 10 feet would necessitate structures that would be expensive, if placed (as I consider they always ought to be placed) in an open field or garden, and thus tend to diminish the number of observers.

In the absence of an universal rule I have adopted 4½ feet in Canada, but I would gladly change it for another higher level.

The exposure of a thermometer involves two conditions:—

1st. That the air in which it is immersed be a fair sample of the horizontal stratum of which it forms a part, and

2nd. That the thermometer be acted on (as far as possible) by contact with that air and by no other cause of change.

The first condition concerns the *place* and the second the *mode* of exposure.

Proximity to a building should be avoided, as the air is affected by contact with walls, which have the temperature which the *general* stratum of air had in a *past* time, and not that which the air for the time being has, on an average, at that level. The *direct* effect of the walls upon the thermometer may be cut off, but not its effect on the *air* in which the thermometer is immersed.

If the temperature be recorded by photography, a building must of course be used, but it should be of a form suited to meet all the requirements of the case.

At most of the Canadian stations the thermometers are attached to a light metallic support in the interior of a small safe or screen formed on the four sides and bottom by very thin sheet iron louvres.

This inner screen is supported by light iron brackets in the interior of a shed usually formed of wood. The back or South side consists of three parallel walls from 1 inch to half an inch thick, separated by spaces from 4 to 6 inches wide, which are open to the East and West. The back walls, or at least the two nearest to the South, extend to the ground. The Southern walls are made close, and not of louvres, to diminish the introduction of air that has been overheated by contact with the Southern face.

The Eastern and Western sides, as well as the doors which face the North, are of light wooden louvres, and extend a little below the bottom of the inner screen.

The bottom of the outer shed is open. The back extends to the East and West beyond the sides in order to prolong the time in which the latter are in shade.

Snow between the partitions of the back or on the louvres is speedily removed.

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Suppl. VII. Mr. Kingston.

Intimately connected with the question of exposure are the following:—

1st. What methods should be adopted to render intercomparable the various observations of temperature that have been taken, and that hereafter may be taken, at different levels and in different circumstances as regards locality and modes of exposure?

2nd. If tables of diurnal variation have been derived from observations taken in given circumstances of level, locality, and modes of exposure, by what modifying process can they be made available for reducing observations taken in different circumstances?

Suppl. VIII. Mr. Symons.

VIII.

Letter from Mr. G. J. Symons in London to Mr. Ch. Jelinek, Vienna.

62 Camden Square, London, N.W.
August 20th, 1873.

Rain gauges.

Dear Sir,

As it will be impossible for me to have the honor of attending at Vienna I must content myself with expressing my earnest wish for the success of the meeting.

I enclose herewith report upon the modes adopted in England for the observation of Solar Radiation* as requested by the Conference at Leipzig, and my friend Mr. Buchan will present to the Congress a specimen of the instruments used.

I do not quite understand from the *Bericht* what decision was arrived at at Leipzig respecting *rain gauges*, but I rather fear that the very extensive series of experiments made in this country were not known to some of the speakers, I therefore think it may be desirable, in order to avoid needless repetition, to state briefly what has been done.

The gauges used in these experiments were constructed in the year 1863 for the purpose of determining with precision whether any difference really existed in the amount of rainfall recorded by gauges differing in the size of their receiving areas. The area of the circular ones varied from 0·8 in. to 452 in. and the square ones had areas of 25 and 100 inches respectively. The largest gauge therefore had a receiving surface more than 500 times as great as that of the smallest.

During the past eight years these instruments have been in nearly constant operation, in three localities, different both in their physical and geological characteristics, and in the character of their rainfall.

After experience had been gained as to the points requiring attention it was found that gauges of any size not less than 3 inches (76mm.) diameter, provided that they are constructed on one pattern, and have their orifices at the height of 1 foot (0·3m.) above the soil, give results agreeing within 1 per cent.

The following table gives an epitome of the results obtained from experiments continued during seven years with gauges of the following diameters:—

Place of Observation.	inch. 1	inch. 2	inch. 3	inch. 4	inch. 5	inch. square 5	inch. 6	inch. 8	inch. square. 10	inch. 12	inch. 24
Calne - -	·93	·96	—	1·00	1·00	·97	1·03	1·03	·98	1·00	1·00
Strathfield - } Turgiss - }	·96	·97	—	·99	·97	·97	·98	·98	·97	·98	1·00
Hawsker - -	·97	·99	·99	1·01	1·00	—	1·01	1·02	—	·99	1·00
Mean - -	·953	·973	·990	1·000	·990	·970	1·007	1·010	·975	·990	1·000

The completeness with which this problem has been worked out renders it less necessary that similar comparisons should be repeated; but if such a course be resolved upon, it may save trouble to those who may be charged with the design, construction, or observation of the instruments, to be forewarned that,

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* See Supplement No. IX.

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unless the very greatest care is taken in every particular, and at every stage of the comparison, discordant results are sure to be obtained. Suppl. VIII. Mr. Symons.

The recommendation that all gauges should be 14 inches (0·36m.) in diameter and 8 ft. 2 in. (2½ metres) above the ground, appears inexpedient for the following as well as other reasons. Rain gauges.

1. A gauge so placed will collect nearly 7 per cent. less than the true rainfall reaching the surface of the ground, and the advantage gained by so great an elevation is not obvious.
2. The use of a gauge having so large a receiving area possesses no advantage over that of one having one-fourth of the area.
3. So large a gauge does not accord with the suggestion of Dr. Mohn to the Leipzig meeting, nor with the practice of this country, of France, America, India, or Australia, in which countries collectively about 5,000 gauges are in operation, very few of which exceed 8 in. (0·20m.) in diameter, or 3 feet (say 1m.) above the ground.

As it is improbable that absolute uniformity will be attained, I hope that it will be resolved that *in every annual publication the height of the orifice of every rain gauge above the ground shall be stated.*

It is also of vital importance that every change in the rain gauge or in its height should be distinctly noticed, and desirable that such note should be at the foot of any record of observations rather than in any other part of a publication.

Perhaps I may in conclusion be allowed to state that if the records of the experiments on other branches of rainfall, such as the influence of elevation, the best materials of which to make gauges, the relative amount collected by gauges with funnels inclined to the horizon, are desired, it will afford me pleasure to forward any information in my power.

IX.

Suppl. IX. Mr. Symons. Radiation.

On the Means adopted in England for the Determination of the Amount of Solar Radiation, by Mr. G. J. Symons.

62, Camden Square, London, August 20th, 1873.

The determination of the amount of Solar Radiation may be defined as that of the greatest heating power of the direct rays of the sun, which probably varies with four causes:—(1) Changes of solar energy; (2) the Sun's altitude; (3) the height of the place of observation, and (4) the state of the atmosphere through which the rays have to pass. Almost every apparatus designed for the determination of this element has been constructed on the principle of the expansion of fluids by heat, but in many cases the direct action has been replaced by indirect action, with no obvious advantage. In England the apparatus used by the large majority of observers has always taken the form of a registering maximum thermometer. The instrument now generally adopted is the final result of many years' experiments by many observers, and as each feature in its construction has a special object, it is necessary to explain each.

1. The bulb of the thermometer is very small, to secure rapid action (great sensibility).
2. The bulb and 1 inch (25 mm.) of the stem are coated with dull black; dull black because it was found that black glass (which was formerly used), having a vitreous surface, reflected many of the heat rays, while the dull black absorbs nearly all which fall upon it. It was found necessary to blacken part of the stem, because otherwise the unblackened stem, being cooler than the bulb, reduced its temperature by conduction.
3. The thermometer is enclosed in a thin glass jacket, of which the bulb has a diameter of about 2¼ in. (57 mm.), from which the air is removed by an air pump.

The object of this outer jacket is the elimination of purely local effects, such as dampness, eddies of wind, &c.

This size of jacket has been found to render the instrument more exactly comparable than a smaller size. The jackets have been tried with (1) open

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Suppl. IX. Mr. Symons. Radiation.

ends, (2) ordinary air, (3) chemically dried air, (4) various gases, (5) partial exhaustion, (6) nearly perfect exhaustion. Of these various methods the last mentioned proves the best.

The instrument thus constructed may be regarded as having only one disturbing element, viz., the temperature of the external jacket. The difference between the temperature of the black bulb and the external jacket is an exact measure of the intensity of the sun's rays. It is found that this difference is the same in whatever position the instrument is placed. By exposing it, therefore, freely to sun and air at a considerable height above the ground we have the jacket so little heated above the temperature of the air that the excess of the reading of the thermometer with blackened bulb above the temperature of a thermometer in the shade may be regarded as a very accurate measure of the intensity of the sun's rays. This object is effected in the manner shown by the accompanying figure. (Cut not given).

Thus arranged, it will with the least possible trouble give results not only strictly comparable at all times and places, but equal, if not superior, in accuracy to any of the costly instruments known to the writer, while in facility of observation and lowness of price it surpasses them all.

In conclusion the writer begs to refer for further particulars to a very able paper by the Rev. F. W. Stow in the Quarterly Journal of the Meteorological Society, April 1873, of which a copy is sent herewith.

Suppl. X.

X.

Prof. Bruhns.

On the Observation of Earth Temperatures.—By C. Bruhns.

Earth Temperatures.

Since the year 1866, I have had observations of Earth Temperature made in the gardens of the Leipzig Observatory, both with long thermometers with rather large quicksilver bulbs and fine bore, which can be read above the surface of the earth, as also with short ordinary thermometers which are fastened on rods and plunged in holes.

The bulbs of the first kind of thermometers were placed at depths of 9·8 7·9, 7·9, 6·2, 4·3, 3·3, 2·4, 2·0, 1·3, and 0·7 feet below the surface, and I have published the results of the observations made with them in the "Results of the Meteorological Observations at the Stations of the Kingdom "of Saxony," (years 3–7.)

The thermometers were very carefully tested before they were sunk and the correction of zero determined accurately to about 0°·10. As the column of quicksilver in the soil is exposed to different temperatures, and extends to more than 18 ins. above the surface, the reduction of the thermometer observations is difficult, in consequence of the variations of temperature, for it is well known that the temperature of the soil in the upper strata depends on that of the air, and is rather changeable. Strictly speaking therefore the corrections which have been applied to the readings of these thermometers must be calculated afresh for each reading, and the thermometers which are sunk, and which are to give the temperature in the ground at different depths, give also data for the corrections. Inasmuch, however, as the continual change of the corrections causes a very troublesome piece of work in the reduction, I as well as the observers at other stations, have contented myself with deducing monthly values for the corrections which have to be applied, and carrying out the reductions with these mean values. Such a table, with the corrections for the Leipzig earth thermometers, will be found in the third and fourth volumes of the above-mentioned "Results," and the values of the readings have been corrected by means of them.

The thermometers which are plunged cannot easily be taken out of the soil, and therefore changes which may take place in them cannot easily be investigated, accordingly in course of time unavoidable errors arise from this. I have not been able to apply the most exact means of determining such corrections, and generally the temperature in the earth, viz., the thermo-electric chain with galvanic action, by means of which method, as is well-known, Oberbergrath Reich, of Freiberg in Saxony, determined the temperature of the rocks in the mines.

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After all, the uncertainty of the temperatures read by long thermometers sunk in the ground and afterwards corrected seems to me to amount to some tenths of a degree and even more.

The earth temperatures which have been obtained from short thermometers at the same time as from these thermometers which have got continuous tubes, have been obtained from instruments plunged in earthen pipes sunk in the ground. The earthen pipes were closed as air-tight as possible on the outside, and the thermometer bulbs were surrounded by a bad conductor of heat, so that when the thermometers are taken out they would keep their temperature for the space of 10 minutes to within 0°·2. We may assume that a state of thermic equilibrium exists between the temperature at the bottom of the pipe and the temperature of the surrounding soil, and so by such short thermometers we can obtain the true temperature of the soil, as soon as we know the conditions of this equilibrium. We have then the great advantage of being able at any moment to examine the thermometers and to compare them with standard thermometers. I have not yet been able to determine accurately enough what these conditions of equilibrium are, or how far the temperature of the air in the earthen pipes differs from the earth temperature, especially when the outside air is colder than the latter. For the present it appears that for temperatures in depths down to 3 feet, on an average, the temperatures of the continuous thermometer, and that of the movable thermometer, agree almost exactly, while in greater depths, (to 10 feet), the yearly mean remains nearly the same, while the annual oscillation in the movable thermometers is almost 2° greater.

The amount of agreement in the monthly means, between the continuous and short thermometers, is shown by the temperatures obtained in the years 1871 and 1872 with thermometers at 10 feet and 3 feet in depth.

Months.	Continuous Thermometer 10 Feet.	Short Thermometer 10 Feet.	Continuous Thermometer 3 Feet.	Short Thermometer 3 Feet.
1871.				
January	38·97	42·26	35·65	36·27
February	38·17	40·51	35·37	35·01
March	38·97	40·41	37·25	37·81
April	42·26	41·90	42·49	42·08
May	45·45	44·37	47·66	47·84
June	50·13	47·17	52·70	52·16
July	53·60	51·80	57·61	57·02
August	55·71	54·55	59·67	59·23
September	55·27	54·91	57·15	57·56
October	54·32	53·11	50·90	51·31
November	45·86	49·95	43·47	44·96
December	41·59	45·73	40·15	40·51
1872.				
January	39·20	42·26	35·47	36·86
February	38·71	40·69	35·78	36·73
March	39·74	40·41	38·84	39·56
April	43·21	42·49	45·19	45·01
May	47·91	46·35	51·44	50·49
June	51·85	49·77	55·94	55·27
July	54·50	52·57	59·72	59·23
August	57·51	54·99	60·80	60·85
September	56·35	56·30	58·69	59·59
October	53·29	54·99	52·75	53·83
November	48·97	51·80	46·58	47·71

The earthen pipes had rather large mouths, and I thought that by narrower mouths I should obtain better agreement. I therefore took wooden pipes, with openings of about 0·2 in. in diameter. Since December 1872 we have obtained the following figures for the short thermometers in wooden pipes and the long thermometers —

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Suppl. X.
Prof. Bruhns.
Earth Temperature.

Months.	Continuous Thermometer, 10 feet.	Short Thermometer, 10 feet.	Continuous Thermometer, 3 feet.	Short Thermometer, 3 feet.	Continuous Thermometer, 1·5 feet.	Short Thermometer, 1·5 feet.	Continuous Thermometer, 8 ins.	Short Thermometer 8 ins.
1872 December -	45·46	49·42	42·26	44·49	40·50	41·58	40·60	39·88
1873 January -	42·69	46·69	39·88	41·94	38·84	40·06	38·98	38·52
February -	40·93	44·56	36·10	38·52	35·35	35·85	34·94	33·98
March -	40·28	43·16	38·16	39·74	39·02	38·77	39·09	37·69
April -	43·02	44·24	43·59	44·56	43·81	44·46	43·12	43·41
May -	46·00	46·40	47·08	47·80	47·52	47·88	46·47	47·41
June -	50·29	49·21	54·28	54·18	56·98	56·52	56·77	56·84
July -	54·54	53·17	59·79	59·76	62·82	61·84	63·21	61·95
August -	56·95	55·90	61·56	61·05	62·85	62·49	63·10	62·31

We see here that the short thermometers plunged in wooden pipes again agree better at shallow depths with the continuous thermometers than at depths of 3 metres, and the oscillations which are observed in the short thermometers are less than those in thermometers with long tubes.

As to the depths which should be chosen for the thermometers, two systems may be adopted; you may either choose definite depths, as I have done lately, of 0·3, 0·8, 1·6, 2·5, 3·3, 4·8, 6·6 and 9·8 feet, or you may choose such depths as will give only oscillations of a definite number of degrees. The latter system, however, cannot be introduced until the oscillations are determined by the former; and besides from year to year the oscillations at definite depths will not always be the same, because they depend upon the temperature of the outside air, I should therefore give preference to the former system.

For the wants of civil life, as, for instance, Agriculture, it seems that greater depths than about 10 feet are hardly wanted in our latitudes, as according to the observations of the last eight years, frost in Germany seldom goes deeper than 3 feet. In higher latitudes greater depths will have to be chosen, and besides, if possible, observations in greater depths might seem to be desirable in stations of the first order, although there too very often the water in the soil will soon set a limit.

Moreover, a great deal depends on the nature of the soil, and especially on the site of observation; as, for instance, whether the thermometers are always in the shade or exposed to the sun. In the garden of this Observatory I have taken the same nature of soil (first 2 feet garden earth, then about 7 feet yellow sand, and then loam), in two different places, and plunged in each a set of earth thermometers, of which one was always in the shade, the other exposed to the sun's rays for the greatest part of the day, and for the last few months have obtained the following results. (The shaded set is marked with A, the other with B:—

Depths in Feet.	0·3		0·8		1·6		2·5		3·3		4·8		6·6		9·8	
Months 1873.	A.	B.	A.	B.	A.	B.	A.	B.	A.	B.	A.	B.	A.	B.	A.	B.
April -	43°45	47°88	43°41	46°80	44°46	46°33	44°46	46°15	44°56	45°79	44°38	44°31	44°46	43°66	44°24	44°13
May -	48·13	53·26	47·41	51·64	47·88	51·08	47·84	50·32	47·80	48·81	47·01	48·09	47·23	47·19	46·40	46·76
June -	57·34	64·51	56·84	61·95	56·52	60·94	55·36	58·32	54·18	57·20	52·34	53·64	51·40	51·94	49·21	50·00
July -	62·17	69·87	61·95	67·28	61·84	65·95	61·02	63·36	59·76	62·24	57·92	58·50	56·48	56·59	53·17	53·92
August	62·89	69·69	62·31	66·52	62·49	65·37	62·28	63·75	61·05	62·89	60·04	60·15	58·86	59·00	55·90	56·41

These figures show, as would be supposed, that the sun raises the temperature in the earth to a very considerable depth, but how great this influence is, and how much in the above figures is to be referred to special local influences, cannot be proved until the observations have embraced a longer period.

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XI.

Suppl. XI.

Description of a Simple Wind-Gauge which can be fitted on any wind vane. By H. Wild.

Prof. Wild.

Report to the Second Sub-Committee appointed to discuss Questions 7–9 of the Programme.

Wind gauge.

In the year 1861 I introduced at the Meteorological Stations of the Canton Berne a *wind vane with a simple wind-gauge*,* which has worked admirably there, and was introduced later to the other meteorological stations in Switzerland, as well as those in the Grand Duchy of Baden. I was afraid that this apparatus would not be suited to stand the severe winter of the North, and so I did not introduce it at the Russian stations until an instrument of that kind had acted for at least two years, without the least disturbance, at the Central Observatory in St. Petersburg. Since that time we have not received a single complaint from any of our stations which have received the new apparatus.

pp. 26, 51.

The *wind-vane* consists of an iron pipe with a steel cap on its upper end, which rests on the steel point of an iron rod, passing through the pipe and therefore turning with great ease round this point. On its lower end the pipe carries on one side the vane, consisting of two plates of sheet iron, inclined at the angle of 20° to each other; and on the other side a rod with a counterpoise of lead; on the upper end of the pipe the *wind-gauge* is fixed. This is composed of a horizontal bar, fastened to the pipe by means of a ring, and serves to hold a rectangular plate of tin. The latter is held at its upper edge, which is somewhat thickened by the points of two screws inserted in the bar which serves as a horizontal axis of rotation for it, and when it turns about them it moves along an arc attached to the same bar; four points attached to this arc serve to determine the angle of deviation of the tin plate, when it, after having first been arranged by the wind at right angles to the wind vane, is disturbed from its vertical position of rest. The plate is 1 foot long and 6 inches wide, and weighs 9 ozs. Originally the points were placed in such positions that the plate, when lifted to them, made the angles of 15°, 40°, 63°, and 76° with the vertical, and this gave, in accordance with the usual estimation of the wind's force, Light, Moderate, Strong, and Stormy winds. This scale of 4, or strictly speaking of 5 parts, has, just as the scale of 10 lately adopted by us, and as all other wind scales in use, so much that is optional that it cannot be satisfactory, and prevents any comparison with the existing wind-force scales. Since at the Meteorological Conference at Leipzig metres per second were recommended as a general measure for wind velocity, it seemed to me desirable to replace all scales of wind-force by one expressed in this absolute measure, so that a very simple instrument might at least give the Force or the Velocity of the wind by approximate measurements according to this measure. For this purpose the above wind-gauge seemed quite suitable. We only have to find out to what angles winds above the velocity of 1, 2, 3, &c. metres per second will lift the plate. Unfortunately the present state of aero-dynamics will not allow us to determine these angles theoretically; they can therefore only be determined empirically.

As soon as the Observatory got last autumn one of Combes' apparatus for testing anemometers I directed one of the assistants of the Observatory, M. Dohrandt, to carry out the empirical graduation of the above-named wind-gauge therewith. I reserve it for M. Dohrandt to give the complete account of his numerous series of observations with this and other instruments, especially Robinson's, and shall only give the final results at which he arrived for the instrument which is now in question.

Under the hypothesis that the plate is 9 ozs. in weight, 1 foot high, and 6 inches

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* H. Wild, Report on the Meteorological Operations in the Canton Berne in the year 1861. Mittheilungen der Natur-forschenden Gesellschaft in Bern für 1862, p. 221.

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Suppl. XI. Prof. Wild. Wind gauge.

wide, the following are the angles in which it is raised by the following winds :—

Wind-velocity in Metres per Second.	Lifting Angle of the Plate.	Wind-velocity in Metres per Second.	Lifting Angle of the Plate.
1	2·0	7	52·6
2	7·0	8	62·0
3	14·0	9	66·3
4	22·8	10	69·9
5	32·7	12	74·2
6	42·3	14	77·0

The apparatus has only been accurately tested up to 10 metres per second ; the two last figures are graphically interpolated.

If we insert on the graduated arc a point at the place corresponding to the angle of each of the even numbers for velocity(excepting12) and so, on the whole, have 6 points, it is very easy, even when the vane is placed on a mast 33 feet high, to read the position of the plate, on an average to within 5° accurately, and so to determine the individual metres per second of the velocity of the wind. According to M. Dohrandt's experience, it is to be recommended not only to take the mean position of the oscillating plate, *but during about 5 minutes to observe the two extreme positions of it ;* as the mean of the latter gives much more easily and certainly the true mean velocity at the time of observation.

In making the plate, care should be taken that the above dimensions should be preserved as accurately as possible, but small variations in the weight even of + 300 grains have only produced slight alterations in the angles of deviation. The pipe which stands before the plate, and so is first struck by the wind, and keeps something off from the plate, has in our instruments a diameter of 0·7 in.

The usual designations of the winds would, therefore, correspond in the following way to the measured velocities :—

Usual Designation of the Wind.	Velocity of the Wind.		
	Metres. Per Second.	Kilometres. Per Hour.	English Miles. Per Hour.
Very light breeze - -	1	3·6	2·2
Light - - - -	2	7·2	4·4
Gentle - - - -	3	11	6·7
Moderate - - -	4	14	9
Moderately fresh - -	5	18	11
Fresh - - - -	6	22	13
Very fresh - - -	7	25	16
Moderately strong - -	8	29	18
Strong - - - -	9	32	20
Very strong - - -	10	36	22
Rather violent - - -	12	43	27
Violent - - - -	14	50	31
Very violent - - -	16	57	36
Moderate storm - - -	18	65	40
Storm - - - -	20	72	45
Heavy storm - - -	23	83	51
Moderate hurricane - -	26	94	58
Hurricane - - -	30	108	67
Violent Hurricane - -	35	126	79

Our wind gauge would, therefore, only enable us to measure the Force or Velocity as far as "*violent wind.*" For stronger winds we must *estimate* the

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degree of force according to the distance the plate passes beyond the last point. If we have to *measure* greater velocities, a second instrument with a heavier plate of the same area may be used, but for such, an empirical graduation will meet with not unimportant difficulties.

XII.

Suppl. XII.

Report on the Inspection of the Scottish Meteorological Stations, by Alexander Buchan.

Mr. Buchan. Inspection.

The instruments I take with me on inspecting stations, are:—

A Board of Trade Barometer.
An Aneroid Barometer.
A Standard Thermometer.
A Rain Gauge testing apparatus, and
A Compass.

On arriving at the station I hang the barometer and aneroid side by side with the barometer at the station; then collect all the thermometers and place them along with the standard thermometer in a basin of water, selecting if possible a room where there is no fire.

After some time has been allowed to elapse the comparison of the different instruments is made.

1. *Barometer.*

The Board of Trade Barometer and Aneroid are compared with the Standard Barometer in the Society's office before and after the visit of inspection.

The Aneroid is taken as a check on the Board of Trade Barometer, since it is found that, however great be the care taken, air does sometimes, though doubtless rarely, get into the tube of the barometer in the transit; and the aneroid enables me to know whether this has occurred *before* or *after* the inspection of the station barometer.

The following readings are taken:—

	Own reading.		Observer's reading.	
Board of Trade barometer -	—	—		
Aneroid - - -	—	—		
Station barometer - -	—	—	—	—

It is seen if the observer can set his barometer (ivory point, &c.) and the vernier, and read off correctly. The liability of such errors of observation occurring at: 1·000 inch, 0·500 inch, or 0·050 inch, either too high or too low, is pointed out to the observers, and how they are likely to happen.

If any air be in the tube of the barometer, I expel it, unless it be a Board of Trade barometer, in which case it must be sent to an optician.

2. *Thermometers.*

At every inspection the thermometers are compared with the Society's standard at least at one temperature, viz., that of the basin of water referred to above which has been in a room of a practically uniform temperature for about two hours, the object being to ascertain whether the mercurial thermometers or the others read any higher than at the previous comparison, or whether any minute portion of the spirit be lodged, unseen, at the top of the tube. It has been found that none of these points can be satisfactorily ascertained unless the thermometers be placed in a fluid of uniform temperature for a considerable time. If any of the spirit be lodged in the top of the tube, I expel it and show the observer how to do it himself.

If I have a list of the errors of the instruments, obtained by a previous comparison, or by certificate from Greenwich or Kew, I am content with the examination of the temperature at one point of the scale; but if I have no such list of errors, a comparison is made at three points, viz., at freezing, if ice can be obtained, at the temperature of the room, and at from 70° to 80°.

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Suppl. XII. Mr. Buchan. Inspection.

The observer reads the thermometers, and goes through the process of setting the maximum and minimum thermometers, that I may see he understands this part of his work, and occasion is taken to point out the liability to error, even by the best observers, of 10° and 5°.

In reading the thermometers special attention is given to see that the underground ones are read properly; that the eye is on a level with the mercury of the thermometers.

Particular attention is paid to the state of the muslin of the wet bulb of the hygrometer, and generally that this instrument is kept in good working order.

The mode of taking the temperature of the sea by boat (or otherwise) and the place where the observations are made are carefully noted, and inquiry is made as to local currents, so as to ascertain whether any currents from heated or cooled sands are likely to affect the readings.

III. *Louvre Board Box for Thermometers.*

The following points are noted:—

1. Its colour outside.
2. ,, inside.
3. In what direction the door opens.
4. Extent of grass plot in which it is placed.
5. The bulbs of minimum thermometer and those of dry and wet hygrometer hang at the same level, viz., 4 feet above the ground, and that the maximum thermometer is hung above the minimum thermometer.
6. Distance of bulbs of minimum thermometer, dry and wet from lower edge of louvres.
7. Fixing of box, if sufficiently firm and secure.

I am directed to give very special attention to these points with the view of securing uniformity in the observation of the important element of temperature at the society stations.

IV. *Rain Gauge.*

The following points are ascertained:—

1. Material it is made of and its construction.
2. Diameter; four diameters being measured.
3. Measure. If measured by a scale the scale is compared with a standard scale. If measured with a graduated glass measure showing 0·10 and 0·01 inch, these measures usually being made to 0·50. Water is poured into the observer's measure and it is seen how many standard grains of water correspond to 0·10, 0·20, 0·30, &c., inch. The graduation of the hundredths are compared with standard scale.
4. Height above ground.
5. Height above sea level and how this has been ascertained.
6. Position, if sufficiently free and open. Distance of any shrubs, trees, walls, houses, &c., from the gauge. The direction in which these obstructions to the free exposure of the gauge lie is noted, and height of these obstructions above the horizon is measured with an Altometer.
7. Position of gauge with respect to hills, rising ground, and valleys, likely to influence the amount of the rainfall of the district where the gauge is placed.

V. *Wind.*

1. *Direction*, how taken, by vane, smoke, &c., and whether the points used by the observer be *true* N., S., E., and W., are ascertained by compass. The direction is entered true, not magnetical, by the observers.

2. *Force*, whether observer gives his estimated force, uniformly with the other observers, is sought to be ascertained by the estimated force he gives at the time of inspection. The scale adopted is 0 to 6, and it is attempted that these conform to Beaufort's scale (0–12) 1 agreeing with 2, 2 with 4, &c.

If, from the past observations of the observer, very much wind or very little wind has been reported from the station, it is inquired into whether the excess

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or defect is due to the erroneous estimations of the observer, or to the fact of really a greater (or a less) force of wind prevailing at the place.

At a good many of the stations, H. C. Anemometers are in use. I cannot however say that the working of these instruments is quite satisfactory. As we have no proper means of testing the correctness of their indications we do not know how many (if indeed any at all) of these instruments give positive results, and it is certain that nearly the whole of them are not comparable *inter se*.

There are also a number of simple pressure anemometers at the stations, which show the maximum pressure of the wind and the pressure at the moment of observation.

VI. *Clouds.*

The estimation of the amount is on scale 0 to 10 from the zenith to altitude 45°.

The species is from Howard's nomenclature.

The direction of motion is estimated, in one or two cases measured by an instrument specially constructed by Mr. T. Stevenson for the purpose.

The correctness of the observer's estimation of the amount, species, and direction of motion, is ascertained.

At several stations both upper and lower clouds are observed when this can be done.

VII. *Evaporometer.*

The evaporation is observed at present at four stations, but there is very great difficulty in securing comparableness in the results of these instruments, and the positions in which they are placed.

VIII. *Ozone.*

Whether Schönbein's, Moffat's, &c., test papers are used is noted, the exact method of exposure, and observer's estimation of depth of tint.

The results of the inspection are entered on a previously prepared blank Form, the details being filled in as the inspection proceeds. The Form secures that nothing is omitted.

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This Index is only a translation from that furnished with the German edition. It is hoped that the copious cross references will in some measure supply the want of a fuller Index.

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OF

THE PROCEEDINGS

OF THE

CONFERENCE ON MARITIME METEOROLOGY

HELD IN

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LETTER OF INVITATION.

Meteorological Office,
116, Victoria Street, London,
25th June 1874.

SIR, Maritime Conference.

I HAVE the honour to inform you, that it has been decided by the Sub-Committee (consisting of MM. Buys Ballot, Mohn, Mouchez, Neumayer, and myself), appointed by the Permanent Committee of the Vienna Congress, that it is desirable to hold a private conference for the discussion of the subject of Maritime Meteorology in London, in the course of this year.

I have received authority from the Meteorological Committee of the Royal Society, to place this Office at the service of the Conference, for its Meetings.

The Conference will assemble on the 31st August, at noon, and will probably last three or four days.

I have the honour to invite you to attend the Conference personally, or to authorize some Meteorologist conversant with the subject of Maritime Meteorology to represent you.

Copies of the programme proposed by the Sub-Committee for the deliberations of the Conference are enclosed for yourself, and for presentation to other gentlemen in your country interested in the subject.

I have already issued copies of this Circular to the gentlemen specified below,* and I hope to receive a reply as to your intention to attend, or the contrary, previous to the 1st of August at latest.

The Sub-Committee will feel themselves deeply indebted to you if you can procure for them written opinions from men of experience in your country who may not attend the Conference, on any, or all of the several subjects embraced by the programme, and send them to me at this Office.

I have the honour to be, &c.
ROBERT H. SCOTT,
Secretary to the Sub-Committee.

* The names of gentlemen in the same country as the recipients of the Circular, to whom invitations had been issued, were here given.

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PROGRAMME

OF THE

CONFERENCE ON MARITIME METEOROLOGY.

A general wish has of late been expressed that the measures for the prosecution of Maritime Meteorology proposed at the International Conference at Brussels, in 1853, should be reconsidered, now that the experience of more than 20 years of the operation of these measures has enabled Meteorologists to form opinions as to their utility.

At the Meteorological Conference at Leipzig in 1872, and again at the International Congress at Vienna, in 1873, preliminary discussions took place on the subject of the more successful prosecution of Ocean Meteorology. Certain resolutions were adopted at Leipzig and confirmed at Vienna, and accordingly it seems proper to embody them in the present Programme. They run as follows:—

"1st. Thorough uniformity in methods and instruments should be aimed at in the same measure as for observations on shore. This will be most satisfactorily attained by the Chiefs of the Central Institutes—the establishment of which in all countries, in which they do not already exist, and in which the maritime interests demand them, must be declared as absolutely necessary—entering into relations with each other and agreeing on the separate details, the construction of the instruments, the hours of observation, the journal, &c.

"2nd. Unity of measures and scales is desirable, and to this end the introduction of millimètres for the barometer and the Centigrade scale for the thermometer should be aimed at. While, however, the comparison of standard instruments of the individual Central Stations must be insisted on, the uniformity of scales is at present only declared as desirable.

"3rd. The Committee would urge the importance of the co-operation of the Navies, inasmuch, as by their assistance, and by the opportunities afforded thereby of completeness in certain observations, the determination of factors and constants is rendered possible, which can be used with advantage for the reduction of certain results derived from the general system of observations.

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"4th. With reference to the utilisation of the results, the Committee would urge similarly the importance of uniformity in the methods employed. In close relation therewith is the carrying out of the division of labour of the Central Stations of the individual states. This principle must be recognized as of the greatest importance for the further development of Marine Meteorology. The repetition of work over definite regions, with reference to the area to be investigated, must be declared as indefensible in the interests of this development."

It was further resolved—"That the convening of a Maritime Meteorological Conference is desirable."

While accepting the above resolutions as a general expression of the principles which should form the basis of an agreement as to future operations in the field of Ocean Meteorology, the Sub-Committee to whom the negotiations preparatory to the assembling of a Conference have been entrusted, consider that it is advisable to enter more minutely into the details, and have accordingly agreed on the following series of questions:—

In the case of a nation which sent any representative to the Brussels Conference, in 1853, a circular should be addressed to the chief of the Office for Maritime Meteorology, if such exist, or to the chief of the Meteorological Organization of the country, requesting him to state:—

1. To what extent the resolutions adopted at Brussels have been carried out in that country;
2. What have been the grounds for departure from them, if such departure has taken place;

and to send his reply to the Secretary to the Sub-Committee, Mr. Robert H. Scott, 116, Victoria Street, London, S.W., before the 1st of June 1874, in order to allow ample time to draw up a report on the replies for consideration at the Conference.

It seems advisable that, as above stated, the action taken at Vienna should be carefully reconsidered under the several heads which will now be recapitulated.

I.—*Observations.* In respect of this subject it will be most convenient to take the "Abstract Log" of the Brussels Conference, and to discuss the several subjects of observation noted therein in the order of sequence of the columns.

Cols. 1—6. *Date and Position of the Observations.*
Is it your opinion that a fresh column should be added, headed "Course and Distance by the Log in every Watch of 4 hours"?

„ 7 and 8. *Currents.*

„ 9. *Magnetic Variation.*
Is it desirable to give an additional column for the "Direction of Ship's Head"?

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Cols. 10 and 11. *Wind, Direction and Force.*
Is it possible to employ an anemometer at sea so as to give trustworthy results?
Can the use of the Beaufort Scale be made universal?

„ 12 and 13. *Barometer.*
To what degree of minuteness is it necessary to observe this instrument?

„ 14 and 15. *Thermometer.—Dry Bulb and Wet Bulb.*
Should these observations be required from all ships?

„ 16. *Forms and Direction of Clouds.*
Is this column sufficient, or should any notice be taken of more than one stratum of clouds?

„ 17. *Proportion of Sky Clear.*
Is it not advisable to substitute for this heading "Proportion of sky clouded"?

„ 18. *Hours of Rain, Fog, Snow, &c.*
Is it desirable to retain this heading, or to substitute for it and No. 23 a column headed—"Weather by Beaufort Notation"?

„ 19. *State of the Sea.*
Should this be given according to a Numerical Scale?

„ 20. *Temperature of Sea Surface.*

„ 21. *Specific Gravity* „ „

„ 22. *Temperature at Depths.*
Is it desirable to retain these two last columns, or can the observations when taken be inserted in the column for "Remarks"?

„ 23. *Weather.* See No. 18.

„ 24. *Remarks.*

II. *Instruments.*—What patterns of instruments should be employed for any observations which may require them?

Is there a reasonable possibility of introducing the Metric and Centigrade systems for general use at sea?

III. *Instructions.*—Is it possible to devise a general form of Instructions to ensure uniformity in regard of methods of observation and registration?

IV. *Observers.*—What control should be exercised over the Observers as to their instruments and registers?

Is it desirable that all instruments employed should be the property of the Central establishment, and *lent* to the Observers?

V. *Co-operation of the Royal Navy.*—To what extent can ships of war assist in forwarding the ends of Meteorological Inquiry?

VI. *Discussion.*—Can general suggestions be thrown out as to the most profitable mode of discussion of the observations?

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VII. *Subjects of Inquiry.*—To what extent can a division of labour as regards subjects of inquiry be carried out in a spirit of fairness to the collecting and discussing establishments respectively?

VIII. *Sailing Directions.*—In how far are purely practical investigations, such as the preparation of Sailing Directions, admissible for a Scientific Institution?

Any gentleman into whose hands this Programme may come, and who is himself not likely to attend the Conference, is requested to forward any remarks he may wish to make, on any of the subjects mentioned herein, to Mr. Scott, at the above address, before the 1st of July 1874.

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LIST OF PERSONS PRESENT AT THE CONFERENCE.

Austria - -	R. Müller - -	Director of the Imperial Royal Hydrographic Office at Pola.
Belgium - -	F. van Rysselberghe	Navigation School, Ostend.
Bengal - -	H. F. Blanford -	Secretary, Meteorological Committee, Calcutta.
China - -	J. D. Campbell -	Inspectorate General of Chinese Maritime Customs, London.
Denmark - -	Capt. N. Hoffmeyer -	Director of the Royal Danish Meteorological Institute at Copenhagen.
France - -	A. Delamarche -	Ingénieur Hydrographique, Ministry of Marine, Paris.
„ - -	C. Sainte Claire Deville	Inspector of French Meteorological Stations, Paris.
Germany - -	W. H. v. Freeden -	Director of the "Deutsche Seewarte" at Hamburg.
„ - -	H. A. Meyer -	Commissioner for investigating the German Seas, Kiel.
„ - -	G. Neumayer -	Hydrographer, Berlin.
„ - -	Capt. Stempel -	Imperial Navy.
Great Britain -	R. J. Mann, M.D. -	President of the Meteorological Society, London.
„ - -	R. Admiral M.F. Nolloth.	Representative of the Admiralty.
„ - -	R. H. Scott, F.R.S.	Director of the Meteorological Office, London, Hon. Sec. to the Sub-Committee.
„ - -	Capt. H. Toynbee -	Marine Superintendent, Meteorological Office (Representative of the Board of Trade).
Holland - -	H. Buys Ballot -	Director of the Royal Meteorological Institute of the Netherlands, Utrecht.
„ - -	Lieut. J.E. Cornelissen	Marine Superintendent, do. (R. Dutch Navy.)
Italy - -	Capt. N. Canevaro -	Naval Attaché to the Royal Italian Legation, London. (R. Italian Navy.)
Norway - -	H. Mohn - -	Director of the Royal Norwegian Meteorological Institute at Christiania.
Portugal - -	J. C. de Brito-Capello	Director of Nautical and Meteorological Observations, Observatory of the Polytechnic School, Lisbon.
Russia - -	A. Moritz - -	Director of the Observatory at Tiflis.
„ - -	Capt. M. Rikatcheff -	Central Physical Observatory, St. Petersburg. (Imp. Navy.)
Spain - -	Capt. H. Montojo -	Spanish Navy.
„ - -	Capt. C. Pujazon -	Director of the Marine Observatory, San Fernando. (Spanish Navy.)

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PROCEEDINGS

OF THE

MARITIME CONFERENCE AT LONDON,

1874.

Meeting of the 31st August, at Noon.

PRESENT:

MM. Blanford.	MM. Meyer.
Buys Ballot.	Mohn.
Campbell.	Montojo.
Canevaro.	Müller.
Capello.	Neumayer.
Cornelissen.	Pujazon.
Delamarche.	Rikatcheff.
Deville.	Scott.
v. Freeden.	Stempel.
Hoffmeyer.	Toynbee.
Mann.	

Mr. SCOTT opened the Conference and said that, in the name of the Meteorological Committee, he felt most highly honoured in welcoming all the gentlemen to the Meteorological Office.

The present Conference, like that of Leipzig, had been called together by a Sub-Committee, appointed by the Permanent Committee of the Vienna Congress of 1873, and it had been thought desirable by a majority of that Sub-Committee to have the Conference *private*, in order to ascertain whether or not there existed a serious difference of opinion on the various questions connected with Maritime Meteorology, and whether or not they could be settled without a Government Congress.

He thought the best plan would be to read out the names, and introduce the members present to each other, and afterwards to proceed to elect the President and Secretaries. Having read the names, he stated that he had received a letter from M. A. Moritz, asking permission for M. van Rysselberghe and himself to attend the Conference, and that he had invited them by telegraph to do so. This action was approved by the Meeting.

On Mr. Scott's proposal, the Meeting chose M. Buys Ballot as President.

M. BUYS BALLOT said he was very sensible of the honour done him, but his task was a difficult one, and he would have liked a better chairman. He hoped the Meeting would excuse his imperfect knowledge of English.

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Mr. Scott was elected a Secretary, and he proposed that M. Hoffmeyer should act with him, and undertake the French portion of the proceedings, a proposal which was approved by the Conference.

Mr. SCOTT said it was unnecessary to read the letters which had been received from gentlemen who accepted the invitation to attend, but he would read those received from gentlemen unable to be present, viz. (vide Appendix A.) :—

MM. Buchan.	MM. Rothe.
Davis.	Rubenson.
Findlay.	v. Wrangel.
Marié-Davy.	v. Wüllerstorf.
Myer.	Wyman.

and he regretted that neither Sweden nor the United States would be represented at the Conference.

The PRESIDENT said the first thing to be done was to learn the opinions about the working of the Brussels Conference, and he called on the Secretaries to read the several written communications which had been received on the subject.

Mr. SCOTT said that letters had been issued to every nation that had sent a representative to Brussels, and stated that replies had been received from every one. The answers had been sent by the following gentlemen ; it would not, however, be necessary to read them all here in full, as they would be referred to the several Sub-Committees to be hereafter appointed. (Vide Appendix B.) The names were :—

MM. Buys Ballot.	MM. Myer.
Capello.	Quetelet.
Hoffmeyer.	Rikatcheff.
Mohn.	Rubenson.
Mouchez.	Wyman.

The PRESIDENT proposed that the meeting should divide itself into two Sub-Committees, viz., one treating of that portion of the Programme which had special reference to *Observations*, and the other to *Discussions*, with power to sub-divide themselves further, if necessary.

This proposal was put to the meeting, and agreed to unanimously.

The first Sub-Committee (Observations) should take into consideration Questions I.–III. of the programme, and the following gentlemen were elected to act on it :—

MM. Capello.	MM. Müller.
Canevaro.	Neumayer.
Cornelissen.	Pujazon.
Deville.	Rikatcheff.
Meyer.	Toynbee.
Montojo.	

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The second Sub-Committee (Discussions) should take into consideration Questions IV.–VIII. of the Programme, and the following gentlemen were elected to act on it :—

MM. Blanford.	MM. Mohn.
Buys Ballot.	Moritz.
Delamarche.	Nolloth.
v. Freeden.	van Rysselberghe.
Hoffmeyer.	Scott.

The other Members of the Conference would have the option of joining one or other of the Committees at their pleasure.

It was arranged that the Sub-Committees should bring up their Reports for discussion as soon as ready, and the President then called on the Meeting to make any general remarks which might assist the Sub-Committees in their deliberations.

M. HOFFMEYER expressed the hope that the logs of merchant ships of each nation should be arranged as much as possible on the same model as those for ships of war, viz., that approved by the Conference.

M. DEVILLE asked if the first Sub-Committee would be charged both with the questions of "observations to be taken," and "the hours of taking the same," and was answered in the affirmative.

M. v. FREEDEN wished the Weather-Book to contain all the absolutely necessary columns together, and to have extra columns for such things as were not actually necessary for seamen.

Mr. SCOTT said it was intended that the first Sub-Committee should undertake all practical questions as to the Observations and Instruments, and the hours of taking the Observations, and it would be composed, as far as possible, of sailors; the other Sub-Committee would take charge of matters which would be discussed in the Offices. As soon as every gentleman had had an opportunity of offering any remarks which he chose, the Conference should formally either accept or reject this Programme which had been proposed by the Sub-Committee.

M. BUYS BALLOT agreed with M. v. Freeden that we should divide the journal into columns of primary and of secondary importance.

M. RIKATCHEFF handed in some remarks, for the consideration of the Sub-Committee, and drew attention to the necessity of special observations on the velocity of the wind, and on the rainfall on shipboard.

The PRESIDENT referred the proposed Programme to the Meeting, and asked whether or not they accepted it as it stood?

Mr. SCOTT drew attention to a proposal by General Myer, as to Synchronous Observations, which was not mentioned in the Programme, and asked if the Conference thought that the question of Synchronous Observations should be included in the Programme.

He himself thought that it should not be so included. We

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must get such Observations from ships' logs, if we can, but it was not possible to treat the matter as one of Maritime Meteorology.

M. NEUMAYER concurred in this view, in so far that at the present stage of the proceedings of the Conference, it had nothing to do with Synchronous Observations, which might, however, be got from the ordinary logs.

CAPT. TOYNBEE said that Synchronous Observations should be made the subject of a special request, and could hardly be included in the form of a ship's log. Those Captains who took them might enter them in the column for Remarks. It might be well if General Myer had circulars printed asking for them. The circulars could be issued to those Captains who observe for the various Maritime Meteorological Offices.

M. BUYS BALLOT said the Captains could have their attention called to it, but it could not be imposed on them.

The Conference then definitely accepted the Programme.

Mr. SCOTT explained the arrangements for the Conference. The Sub-Committees should meet at 11 o'clock, and sit till 1h., and again from 2 to 4 o'clock. On Wednesday afternoon, or Thursday, the Conference in full would receive and discuss the Reports of the Sub-Committees.

BUYS BALLOT.

Meeting of the 2nd September, at 2.30 p.m.

PRESENT:

MM. Blanford.	MM. Mohn.
Buys Ballot (President).	Montojo.
Canevaro.	Moritz.
Capello.	Müller.
Cornelissen.	Neumayer.
Delamarche.	Nolloth.
Deville.	Pujazon.
v. Freeden.	Rikatcheff.
Hoffmeyer.	van Rysselberghe.
Mann.	Scott.
Meyer.	Stempel.
	Toynbee.

The PRESIDENT said that the Resolutions of both the Sub-Committees had been printed and were in the hands of the Members. They would be brought before the General Meeting as soon as the Proceedings of the last Meeting had been read.

The Proceedings of the previous Meeting were read and confirmed.

The PRESIDENT reported that MM. Moritz, Nolloth, and van Rysselberghe, who were not present at the first Meeting, had

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since arrived and had taken part in the labours of the second Sub-Committee and he thanked them for their assistance.

He then requested Mr. Scott to proceed with the reading of the several questions enumerated in the Programme, and the Resolutions of the respective Sub-Committees upon them. At the same time he requested the Members of the Conference to make remarks upon the Resolutions to be brought forward, suggesting that, owing to the short time available for discussion, any observations they might wish to make ought to be well considered, and of weight, since the different Committees had already considered the Resolutions in detail.

The Conference then passed to the consideration of the Resolutions of the First Sub-Committee. The "Abstract Log" of the Brussels Conference was taken, and the several subjects of observation noted therein were discussed in the order of sequence of the columns.

Resolutions passed by the First Sub-Committee.—

"Observations."

1°.* "That there should be but one form of Meteorological Register for the Navies and Merchant Services, and that those that cannot fill the log should keep part of it."

The Second Sub-Committee stated that they had resolved to recommend that there should be two kinds of Register.

M. v. FREEDEN said it would be better to have a log which did not require so much education in the observers. He would give an opportunity of keeping some columns, and would introduce other columns to be filled at pleasure, but there should be only one kind of log.

CAPT. TOYNBEE thought that the logs of the Meteorological Office were sufficient for all practical purposes; in them the four-hourly periods were printed in large type.

M. NEUMAYER also said that he should prefer only one form of log.

The Conference then divided on the question, and it was decided by 14 votes against 9 that there should be but one form of Register.

The PRESIDENT remarked in announcing the majority, that as regards the columns in this general log, and as to the question, which of them were the most important, each Institute would select columns according to the country and to its own requirements.

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* The figures marked thus 1° are the several Resolutions.

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Question I.: *Observations.*

Cols. 1—6.* *Date and Position of the Observations.*

Is it your opinion that a fresh column should be added, headed "Course and Distance by the Log in every Watch of four hours"?

2°. "That an additional column should be given in the log for 'Course and Distance.'

3°. "That the course should be expressed in degrees and not in points."

4°. "That the question of hours, 4-hourly periods, as proposed by Captain Toynbee (Appendix C.), and in general use by Dutch and German Captains since 1865, should be adopted."

It was here decided, on the motion of the PRESIDENT, that Capt. Toynbee's Report on the Programme, which had been laid before the Sub-Committees should be printed in full, and embodied in the Report of the Proceedings of the Conference, as Appendix C.

CAPT. TOYNBEE referred to the importance of 4-hourly periods in calculating the Diurnal Range, and said that the work would suffer by the introduction of intermediate hours.

M. v. FREEDEN proposed as an amendment that the course should be expressed in points and parts of points.

On a division the Amendment was negatived by 17 votes against 6.

The Resolutions were then adopted.

Cols. 7 and 8. *Currents.*

5°. "That observations on the 'Direction' and 'Rate' of currents be transferred to the column for Remarks."

Adopted.

Col. 9. *Magnetic Variation.*

Is it desirable to give an additional column for the "Direction of Ship's Head"?

6°. "That an additional column be given in the log for the direction of the Ship's Head and the amount of Heel to Port or Starboard."

Adopted.

7°. "That the Total Compass Error, and not Variation only, should be given."

Adopted.

8°. "That the Conference expresses its opinion that the lettering on the English compass should be adopted by all nations for Meteorological purposes."

Adopted.

* The numbers of the columns refer to the Brussels Abstract Log.

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Cols. 10 and 11. *Wind, Direction and Force.*

Is it possible to employ an anemometer at sea so as to give trustworthy results?

9°. "That a decided answer to this question cannot at present be given, but it is desirable that various anemometers should be tested by special ships, and that a special form of four extra columns should be prepared for the purpose of recording such observations."

Adopted.

Can the use of the Beaufort scale be made universal?

10°. "That the use of Beaufort's scale should be continued, with the addition of the amount of sail which Beaufort's ship would have carried, had she been rigged with double topsails. Also that the Direction and Force of the wind should be recorded *at the time of observation* and *not estimated for a certain number of previous hours.* Also that it should be recorded every two hours."

Adopted.

Cols. 12 and 13. *Barometer.*

To what degree of minuteness is it necessary to observe this instrument at sea?

11°. "To one hundredth of an inch, or its equivalent in the metric scale."

Adopted.

Cols. 14 and 15. *Thermometer. Dry Bulb and Wet Bulb.*

Should these observations be required from all ships?

12°. "That wet and dry bulb observations are desirable, and should be obtained whenever possible."

Adopted.

Col. 16. *Forms and Direction of Clouds.*

Is this column sufficient or should any notice be taken of more than one stratum of clouds?

13°. "That the upper and lower clouds should be recorded in separate columns, and that the direction from which *upper* clouds come should be recorded when possible."

Adopted.

Col. 17. *Proportion of Sky Clear.*

Is it not advisable to substitute for this heading, "Proportion of Sky Clouded"?

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14°. "That it is preferable to give the proportion of sky clouded, instead of the entry of 'proportion of sky clear' as recommended by the Brussels Conference."

Adopted.

This regulation is identical with that recommended by the Vienna Congress.

Col. 18. *Hours of Rain, Fog, Snow, &c.*

Is it desirable to retain this heading, or to substitute for it and No. 23 a column headed "Weather by Beaufort Notation"?

15°. "That it is desirable to retain this heading, but that the use of Beaufort's Notation may be continued by those accustomed to it."

Adopted.

Col. 19. *State of the Sea.*

Should this be given according to a numerical scale?

16°. "That a numerical scale (0–9) be adopted, and that an extra column should be given to the Observation. The direction of the sea, swell, or the different swells to be given in the original column."

Adopted.

Cols. 20 to 22. *Temperature of Sea Surface. Specific Gravity. Temperature at Depths.*

Is it desirable to retain these columns, or can the Observations, when taken, be inserted in the column for "Remarks"?

17°. "That the first two of these columns be retained."

Adopted.

18°. "That sea temperatures at depths should not be required from all ships, and that they should be recorded among the Remarks."

Adopted.

Col. 23. *Weather.*

19°. *Vide* the Resolution on column 18.

Col. 24. *Remarks.*

20°. "That the 'Remarks' as asked for by the Brussels Conference should be adopted, with the exception of the Observations of temperature with coloured bulbs at sea."

Adopted.

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Question II. *Instruments.*

What patterns of Instruments should be employed for any Observations which may require them?

21°. "That the question of the precise pattern of Instruments is not of very great importance, so long as they satisfy the tests applied at the several Central Institutions, and are compared with Standard Instruments, but it is recommended that they shall be of a pattern as easy as possible for reading."

Mr. BLANFORD proposed as an amendment, that it should be specially stated that all barometers should be so constructed that the light could be let in behind the tube. Some old-fashioned barometers, still used at sea, were opaque behind. Sometimes the mercury is read, not at the top of the meniscus, but where it touches the glass. Mr. Blanford wished to urge this addition to stop the construction of barometers of the kind he above referred to.

M. BUYS BALLOT also pointed out that it was desirable that the top of the glass tube should be visible.

M. NEUMAYER pointed out that these questions had been dealt with, and settled by the first Sub-Committee.

After some remarks in the same sense by Admiral NOLLOTH, Mr. SCOTT and Captain TOYNBEE, the Resolution was adopted.

A discussion then arose as to the use of the rotatory thermometer (thermomètre fronde).

Mr. SCOTT proposed, that it be recommended that some experiments should be made with this thermometer, which had been found to give very good results, and he thought it might be used with advantage at sea.

M. DEVILLE stated that he supported this view warmly.

It was then explained that the first Sub-Committee had determined to abstain from referring to any special Instruments, but that there would be no objection to such observations as those referred to being made as well as other experiments.

Is there any reasonable possibility of introducing the Metric and Centigrade systems for general use at sea?

22°. The recommendation respecting the use of the Metric and Centigrade systems, as expressed at the Vienna Congress, is approved, and it is recommended that a table of conversion should be entered in each log, to enable Captains to compare barometers which have different scales.

Adopted.

M. DEVILLE here remarked that he thought the first Sub-Committee had paid too much attention to mere forms, and had not entered sufficiently into the details of the subject of Instruments, which he considered of paramount importance.

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Question III. *Instructions.*

Is it possible to devise a general form of Instructions to ensure uniformity in regard of methods of observation and registration?

23°. "That the Instructions should be suited to the log now proposed by the Conference, but modified to meet the various requirements of different Nations."

Adopted.

24°. "The Conference requested that Captain Toynbee's proposed form of log should be printed, and the English 'Instructions' printed for circulation amongst its members."

Adopted.

The Conference then proceeded to the Consideration of the Resolutions of the Second Sub-Committee.—"Discussions."

Question IV. *Observers.*

What control should be exercised over the Observers, as to their Instruments and Registers?

25°. "That it is necessary that all instruments used should be compared with standard instruments, either at the central or the filial Institutions (if such exist), before and after the voyage, and that the corrections and date, &c. of the comparisons should be entered in the log."

Adopted.

Is it desirable that all instruments employed should be the property of the Central Establishment, and *lent* to the Observers?

26°. "That it is desirable that the Instruments should be the property of the Central Office."

Adopted.

27°. "That it is necessary that a careful examination should be made into the quality of the Observations recorded, and that the attention of the Observers should be specially directed to any errors which may have been detected."

Adopted.

Question V. *Co-operation of the Royal Navy.*

To what extent can ships of war assist in forwarding the ends of Meteorological Inquiry?

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28°. "The Royal Navy can furnish more complete Observations than are possible on board Merchant Ships, *e.g.*:—

Deep-sea soundings and temperatures.

Observations in unfrequented parts of the sea.

Special experiments.

"It is most desirable that the duty of observing should be entrusted to some responsible Officer.

"It is therefore resolved, that the Authorities of the Navies shall be requested to continue to give such assistance to the prosecution of Meteorological Science as circumstances shall permit."

A Report was handed in which had been drawn up by a number of the members, who were in the Naval Services of some of the countries represented, in regard of the co-operation between the Navies and the Merchant Services.

This Report led to a discussion, in which MM. BLANFORD, v. FREEDEN, MANN, NEUMAYER, NOLLOTH, RIKATCHEFF, SCOTT, and TOYNBEE took part.

It was finally decided by the Conference that the following Resolutions, contained in the Report, should be adopted in lieu of that given above, and entered on the Protocol of the Meeting, as follows:—

A. "It is very important that the organization of Meteorological Inquiry, as regards the Navies of all countries, should be arranged in accordance with the principles and stipulations laid down by the Conference for Marine Meteorology generally, and it is further important that the results of all Observations made on board ships of war in any country should be rendered accessible for discussion by the Central Station for Maritime Meteorology in that country, without prejudice to any subsequent publication by the respective Naval Authorities."

B. "The Conference, while admitting that the introduction of measures calculated to improve the condition of Meteorological Inquiry in the Navy must be left to the Authorities of the respective Navies, is nevertheless of opinion that all care should be taken to secure uniformity as to mode of Observation, and especially to provide for the comparison of all instruments used with the respective standard Instruments of the Central Institutions."

C. "The Conference considers it to be its duty to request that those entrusted with the management of scientific affairs on board men-of-war will lend their strenuous support in securing from the Naval Authorities in each country, such regulations as will place Meteorological Inquiry on board such ships in as favourable a position as may be deemed consistent with the execution of the ordinary duties of the service, and will also induce the Commanders to render to such Inquiries all the assistance and furtherance in their power. The Conference knowing that such regulations must be framed according to the requirements of each

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Country, expresses, nevertheless, its opinion that, inasmuch as Meteorological Investigations require considerable experience, they should be entrusted to experienced Officers on board suitable vessels."

D. "Although the Conference is of opinion that, as far as the general scope of Meteorological Inquiry goes, the same form of Register should be supplied to Merchant Ships as to Men-of-War, it declares it will be most desirable that, besides the regular observations, a more extended scale for scientific inquiry should be adopted on board ships-of-war; as in such cases there is a larger number of suitable Officers, as well as more means for carrying on the service. As examples of observations which are of importance for the development of Maritime Meteorology, over and above the regulations embodied in the scientific instructions given to Naval Expeditions for the special purpose of advancement of science, the following suggestions may be enumerated:—

1. Possibility of carrying out accurate observations on the velocity of the wind by anemometers at sea.

2. Possibility of employing rain-gauges satisfactorily at sea.

3. Observations with Regnault's or other hygrometers, and experiments on the best mode of observing wet and dry thermometers, and the best position for them on board ship.

4. Currents at the surface and at depths to be observed with great minuteness with the special object of defining their limits.

5. The comparison of various instruments among which are expressly mentioned that of aneroids with mercurial barometers. It is further deemed very desirable that frequent comparisons should be instituted between instruments used at sea and those of Meteorological Stations on shore in various Countries.

6. Deep sea soundings and temperatures, with specimens of water.

7. The collecting of information on Ocean Meteorology at outlying stations.

9. The furnishing of Synchronous Observations at 0h. 43m. Greenwich Mean Time, in accordance with the suggestion and request of the United States Signal Office."

Question VI. *Discussion.*

Can general suggestions be thrown out as to the most profitable mode of discussing the observations?

29°. "That it is desirable that every Institution should publish the observations and results in such a manner that every foreign Institute can incorporate them with its own observations and results in the easiest way possible, that is, by preserving the *number* of observations, together with any means derived from them, for single degrees square."

Adopted.

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30°. "That it is further desirable that whatever Charts be published, the results for single degrees square should be published in a tabular form."

Adopted.

31°. "That it seems desirable for the use of the Sailor, that each Chart should have reference to only one element, or at least only to elements closely related to each other."

Adopted.

Question VII. *Subjects of Inquiry.*

To what extent can a division of labour, as regards Subjects of Inquiry, be carried out in a spirit of fairness to the Collecting and Discussing Establishments respectively?

32°. "That the division of labour, as regards investigations, can only be carried out by mutual agreement between the several Institutions, and each Institution should announce to other Institutions what investigations it proposes to undertake.

"It is very desirable that such divisions of labour should be effected."

Mr. SCOTT stated that the second Sub-Committee had carefully considered the question of requiring payment for copying observations as mentioned by himself both at Leipzig and Vienna, but without deeming it advisable to pass a Resolution respecting it.

The CHAIRMAN said that there could be no doubt that every nation had the right to require such payment.

The Resolution was then adopted.

Question VIII. *Sailing Directions.*

In how far are purely practical investigations, such as the preparation of Sailing Directions, admissible for a Scientific Institution?

33°. That the sailor wants the results of experience alone, and he must receive assurance that his observations have been turned to use. When these results of experience have been given, the theorist may point out the reason why certain routes are the best.

Adopted.

The discussion of the Programme being concluded—

Mr. SCOTT stated that he wished to take the opinion of the Conference as to what communications should be printed in the Official Report of the Proceedings of the Conference.

He proposed—

1. That letters from gentlemen accepting the Invitation to attend should not be printed.

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2. That the information respecting the working of the Brussels Conference in each Country should be printed.

3. That replies from gentlemen who were unable to attend should be printed in full.

4. That only the Remarks of Capt. Toynbee which had been discussed by the first Sub-Committee should be printed.

These proposals were agreed to by the Conference with the following exceptions:—

M. RIKATCHEFF wished a selection from his own and other gentlemen's communications regarding the Programme, to be printed, in addition to those of Capt. Toynbee, if they were found to contain any new ideas.

Mr. SCOTT promised compliance with this request and stated that he hoped to have the Report ready by the end of November.

The PRESIDENT said that before bringing the Meeting to a close, he would be glad to hear any further suggestions which any gentleman might wish to make.

After a few remarks by Capt. HOFFMEYER, the PRESIDENT congratulated the Conference on having completed their labours in a most satisfactory manner, and said he considered that the important Resolutions which had been arrived at would have the greatest influence on the future prosecution of Maritime Meteorology in all Countries. He appreciated highly the fact that all the deliberations have been conducted in such a liberal spirit, and without laying down too many written rules, so that much liberty was left to each Member, according to his own responsibilities.

He spoke in flattering terms of the effective manner in which the Office, which he and the other gentlemen had had the opportunity of seeing, was managed, and thanked the Meteorological Committee for their great kindness in allowing the Conference to meet in their Office, and for the excellent arrangements made for convenience and comfort of the Members.

On the motion of Mr. BLANFORD a vote of thanks was given to the Secretaries of both Sub-Committees.

Mr. SCOTT, in replying, thanked the Members collectively for their attendance at the Conference, and said that when he was at Vienna, in 1873, one of the gentlemen present had assured him that if invitations were issued for a Maritime Conference in London, every one would attend. The result, as they saw, had more than justified his friend's anticipations.

He ventured to express his own opinion that the fact that the Conference had conducted its deliberations so speedily and satisfactorily had been mainly due to the decision arrived at by a majority of the Sub-Committee to the effect that the Conference should be of a private and not of an official character.

The Report would be submitted to the Permanent Committee at their Meeting at Utrecht on the 10th September, and prior to that date the Resolutions would not be published.

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He expressed the hope that the present deliberations would render another Maritime Congress unnecessary for at least another 20 years.

In conclusion he could not permit the Conference to separate without alluding to the serious losses which Meteorology had sustained. Since the Congress at Vienna last year, one had been taken from among the Delegates to that Meeting, and also, still more recently, a veteran Meteorologist had passed away, whose labours in the science had extended over a period of 40 years, and who had presided over the first Maritime Conference at Brussels in 1853.

He (Mr. Scott) did not presume to speak of the loss which Astronomy had sustained in the death of two of its ablest followers, but on the part of all Meteorologists he wished to offer a tribute of respect to the memory of MM. Donati and Quetelet.

Dr. MANN proposed a vote of thanks to the President for the able manner in which he had conducted the business entailed upon him.

M. BUYS BALLOT, in acknowledging this compliment, which was passed by acclamation, declared that the second Maritime Conference was now closed.

BUYS BALLOT.

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APPENDIX.

Appendix A.

Letters received from Gentlemen unable to attend the Conference.

A. Buchan, Secretary, Scottish Meteorological Society, Edinburgh.

Your letter to the Marquis of Tweeddale, dated June 1874, inviting his Lordship or a representative to attend the private Conference on the subject of Maritime Meteorology which is to meet on the 31 prox°., has been remitted by his Lordship to the Council.

I am directed by the Council to inform you that his Lordship is, owing to the state of his health, obliged to decline the invitation, and that, with reference to a representative, the Council are, owing to want of funds, not in a position to send one.

I am further directed to say that in connexion with this subject, the Council will be happy to give any information in their power, and that they have instructed Mr. Stevenson and myself to forward to the Sub-Committee their opinions regarding some of the subjects embraced by the Programme.

Rear-Admiral C. H. Davis, Superintendent, U.S. Naval Observatory, Washington.

The Hydrographical Office having been created several years ago, by removing from the Observatory all charge of the subject of Meteorology, Maritime or Continental, I have been unable to serve the objects set forth in your communications in any way so well as by the reference which has been made.*

Wishing the largest success to the able Meteorologists who are to prosecute further this most interesting and, practically, most useful branch of Science.

A. G. Findlay, F.R.G.S., London.

I regret to say that long-continued bad health will prevent me from being present at the Maritime Conference to-day as I had hoped, until this morning, to be able to do.

I should have been gratified if I could aid in any way the topics which have been of great interest to me for many years and more especially those included in cols. 7 and 8, 20, 21, 22, and § VIII.

H. Marié-Davy, Central Meteorological Observatory of Montsouris, Paris.

I am, it is true, directed by the Minister, to study your Meteorological materials in London, Greenwich, Kew, and Oxford; but I am a member each year of the Council of Professors of Physics of our Lyceums, and the Session which commences about the 14th August generally lasts till the 5th or 6th September. I should, therefore, arrive too late to take an active part in your interesting meetings, which I much regret. I shall be happy, however, to find some of the *savans* who are to attend the Conference still in London.

Brigadier-General A. J. Myer, Chief Signal Officer, U.S.A., Washington.

It will not be practicable for this Office to be represented at the meeting of the Sub-Committee. We are oppressed with work this summer.

The only point I would urge, if present, would be an arrangement for an International Exchange of a simultaneous report. This, indeed, is in effect, already provided by the action of the Vienna Congress, the proposition adopted by that Congress, embracing in its view as well observations taken at sea as on the land.

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* Letters referred to General A. J. Myer, Chief Signal Officer, U.S.A., and Commodore Wyman, Hydrographer, U.S.N.

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The ship's chronometer will enable the simultaneous observations to be easily made at the proper time. The latitude and longitude in which each is taken can be readily determined sufficiently well later, by computation of the "Dead Reckoning," in the very numerous instances in which Astronomical Observations cannot be had.

A series of simultaneous reports will be, for the work of this Office, of the greatest advantage.

In any form of blank, provision ought to be made for the record of, at least, one simultaneous report, with latitude and longitude of place of observation, the report to be co-incident with those now taken on land. The number of continental and insular stations simultaneously reporting has reached 281.

Commodore H. P. Rothe, Hydrographer, Copenhagen.

I have the honour to acknowledge the receipt of your agreeable invitation to attend the Maritime Conference assembling on the 31st August in London, and I beg you to excuse the delay of my answer, on account of a long absence from Copenhagen.

I regret sincerely, on account of official business, not to be able to be in London at the time fixed, and partake in the discussion on the many and highly interesting subjects put forth in the Programme, but I beg to assure you of my greatest interest in all matters relating to Maritime Meteorology, and that I will do everything to introduce in Denmark the measures which may be adopted after the deliberations of the Conference.

Dr. R. Rubenson, Central Meteorological Institute, Stockholm.

I have the honour to acknowledge the receipt of your invitation to the Maritime Conference in London. As I am just now on the point of starting on a tour of inspection of our northern stations, I must give up the idea of taking part in this Conference. I hope, however, that the decisions which will be taken will advance Maritime Meteorology and will do all in my power to give effect to these decisions in this country.

I have communicated the invitation to some persons interested in the subject, but I have not yet heard whether they intend to forward any written replies to the Conference.

I refer you to my previous letter as to arrangements made here since the year 1853.

Baron v. Wrangel, Hydrographer, Nicolaief.

Your letter of the 25th June with enclosed Programme of the Conference for Maritime Meteorology arrived at Nicolaief during my absence. Having just now returned from an official tour in the Black Sea, I hasten to let you know that pressing business prevents me from making use of your kind invitation for the Conference. However, I enclose the expression of my views on the questions mentioned in the Programme.*

Vice-Admiral Baron v. Wüllerstorf-Urbair, Gratz, late Commander of the Austrian Circum-Navigation Frigate "Novara."

Although I have already written to Dr. Jelinek that it is not possible for me to accept your invitation this year, and especially at the end of August, I consider myself bound to give you notice of the same, not because my presence at the Conference appears to me necessary, but because I wish to express my regret at being unable to make your acquaintance personally and meeting men whom I respect and esteem, and whose excellent contributions to the domain of Meteorology I acknowledge with admiration.

*** This letter was accompanied by remarks which were laid before the Conference and carefully considered.

Commodore R. H. Wyman, U.S.N., Hydrographer, Washington.

I have the honour to acknowledge the receipt of your letter of the 25th June containing an invitation to attend the private Maritime Conference in London, with the request that I forward to the Conference my opinion in answer to the

* Printed in Appendix C.

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questions contained in the Programme accompanying your letter. After consulting with Commodore Daniel Ammen, U.S.N., the Chief of the Bureau of Navigation, this Office being under that Bureau, I have the honour to inform you that the Navy Department do not consider it expedient at the present moment to send an officer to the Conference, and that I am authorized to forward for your consideration the opinions enclosed.*

Appendix B.

REMARKS ON THE RESULTS OF THE BRUSSELS CONFERENCE IN VARIOUS COUNTRIES REPRESENTED AT THAT CONFERENCE.

Meteorological Office, 116, Victoria Street,
London, 7th May, 1874.

SIR, *Maritime Meteorology.*

The Sub-Committee appointed by the Permanent Committee of the Vienna Congress, propose to hold a Meeting in the course of the present year, to discuss the subject of Maritime Meteorology, with especial reference to the decisions taken thereon at the Brussels Conference in 1853, in order to ascertain whether or not it will be advisable to hold an official Conference on the subject in 1875, or later.

As ——— was represented at Brussels by ——— , I am to request you to be so good as to furnish to me, before the 1st of June, or as soon after as convenient, replies to the following questions, in order that I may prepare an abstract of the replies for submission to the proposed Meeting.

1. To what extent the resolutions adopted at Brussels have been carried out in your country?

2. What have been the grounds for departure from them, if such departure has taken place?

If this matter does not fall within your own Department, I shall be obliged if you will kindly forward the communication to the proper quarter.

I am, &c.

To each country Represented at Brussels. ROBT. H. SCOTT,
Director.

Professor Buys-Ballot, Royal Meteorological Institute, Utrecht.

I have from the beginning thoroughly opposed the Resolutions of the Brussels Conference. I was, however, bound to observe those regulations because of the American publications which were carried on in accordance with them. But as soon as the Dutch Institute had its own publications, I adopted another form of log.

The Brussels Conference asked for too many observations, *e.g.* psychrometer, specific gravity, &c., which we could not expect to be made accurately by Merchant Ships, and which are of no use to them. Moreover, the hours 3 and 9 were not convenient. The true course and distance which are of practical use for Sailors and Directors of Institutes were not required.

I beg to refer you, for further particulars, to the following extracts from my printed papers:—

1°. "Suggestions on a Uniform System of Meteorological Observations."

"The Congress held at Brussels aimed at accomplishing too much, and thence many were discouraged.

"Or how else shall we account for it, that especially in the Netherlands, which soon declined to observe these directions, most observations have been sent in.

"In all probability it would have been sufficient to confine the observations to the end of the watch kept on board a ship, and not to ask for too much information. If I may be allowed to state, what has in this country attracted most attention, and with respect to which we have been supplied with the most and the best observations, it will be this:—

* Printed in Appendix C.

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" 1. We require at the beginning of the log book a statement of the corrections of the instrument, after they have been examined by persons appointed for that purpose by the Central Observatory.

" 2. The number of days the ship was at sea.

" 3. The conjectured and observed position of the ship.

" 4. The heights of the barometer by the mercurial barometer.

" 5. The direction and force of the wind.

" 6. The temperature of the surface of the sea.

" No one will deny to these observations their high practical and theoretical value.

" 7. Deviations of the compass.

" On entering a port, or whenever there is an opportunity at sea to veer the ship, the deviations are verified. The safety of the ship depends too much on the local deviations, that time may well be sacrificed.

" 8. The Temperature observations, if there be any place on board fit for taking them.

" Psychrometrical observations; how much rain fell in one day; deep sea soundings, etc., may be safely left to the interest of captains themselves and to such opportunities as are afforded.

" What is of most importance to navigation must have the greatest weight with us."

2°. "A Sequel to the Suggestions on a Uniform System of Meteorological Observations."

"I do not see any safer means of knowing the average indication of the instruments, for every time of the year and every place, than to note in our registers every observation on a different page according to the place in the ocean, and separately for every day of the year, that we may be able to make a graphic table of these observations, and to see if any districts of the sea have some phenomena in common, and what are the boundaries of these districts.

" Unhappily it is not sufficient to form squares of five degrees *d priori* for it will often be the case that one half of such a square shows a digression from the mean opposite to that of the other half. For instance, if we seek the limits of the Trade Winds, shall we find them by studying only large squares, viz. from 15° to 20° lat., and from 20° to 25° long., &c.? Are they at the same latitude in different longitudes? It is impossible to determine them, if we do not know what passes at every square degree, at every square minute of a degree. Sooner or later, therefore, some one will come to the system of giving separately what has been observed at separate points of space and time.

" This is possible, as I will show by describing at some length one of the methods to obtain it, which is followed at the Dutch Institute. We shall be happy if other Directors describe their own methods that we may compare and judge.

" Every Meteorological Journal, sent in to the Institute, is copied on sheets of paper, with printed lines and columns all of the same model on one side, blank on the other.

" Every line of this copy bears the number of the Journal, in order that every questionable entry may be checked by the original; further, the date and the place when and where the observations, put down in the following columns, were taken.

"Then by scissors the paper is cut into horizontal slips, so that each slip contains no other observation than that taken at the same degree of latitude and longitude.

"These separate slips are put in different covers, each containing the observations of a fifth or tenth degree square; they are lightly bound together in 12 different bundles corresponding to the 12 months.

" When we think we have a quantity sufficient to make a study of them, these slips are arranged according to time and place, and since they strictly correspond to the breadths of the columns, we can easily follow their indications, draw up a chart of large size for such a portion of the ocean as we are then treating of.

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"If it be objected that we might have done so from the first, we answer that so doing takes too much time and requires much more attention; that it is much more fatiguing and wearisome to extract observations from the Journal—now here, now there—than to do twice the work, but each time without fatigue.

"Moreover, by this method we get a means of checking which otherwise is possible only by doing it over again from the beginning.

"If now we have recorded the observations of one instrument on one chart, the observations of the other on another chart, we are able to publish either for a single degree square, or even for smaller parts, if there is a fair number of observations, or to join several such degrees into a larger space, and to give its average value."

J. C. De Brito Capello, Observatory, Lisbon.

In reply to your letter of the 7th instant, I will answer the two questions respecting Maritime Meteorological Observations.

Portugal has adopted all the Resolutions of the Brussels Conference. Consequently the Government ordered, in 1854, that all men-of-war should be furnished with Meteorological Instruments as recommended by the Conference, with blank "Abstract Logs," and Instructions of the same Conference, very carefully translated by M. Pegado, Director of Nautical Observations at the time mentioned.

Since 1854, most of the men-of-war have taken Meteorological Observations, and some have obtained rewards from Lieutenant Maury.

The merchant ships have also made Meteorological Observations, and one received a gold medal from the French Government. You have some of the Abstract Logs of both services in the Meteorological Office.

Generally speaking, we have conformed to all the regulations of the Conference; we have only departed from them in some points of detail.

The Two-hourly Observations seemed to us too much for our sailors, who were commencing the work.

Thus we have adopted for men-of-war the hours proposed by the Conference for merchant ships, but we have retained all the vertical columns of the Abstract Log of the men-of-war.

The headings of these columns are retained in the English language.

All the men-of-war carry at least a barometer by Adie with metric scale, and an aneroid for comparison, or, in case of accident to the barometer; two or three thermometers by the same maker, with centigrade scales, one being used as a wet bulb; and two hydrometers. All these instruments are compared with Standards at this Observatory. They also carry a metal bucket with two valves for getting water from a depth.

The merchant ships have taken observations with the same Abstract Log, and some have increased the hours of observation.

We have never employed self-registering thermometers for temperatures at depths; the depth has never exceeded 5 or 10 fathoms except in a few special cases.

Most of the ships of war have also taken observations while lying at anchor.

Capt. N. Hoffmeyer, Royal Meteorological Institute, Copenhagen.

The question having been discussed by a Commission, consisting of Members of the Royal Society of Copenhagen and others, the Ministry of War decreed, on the 23rd of April 1853, that in future, on board the Danish men-of-war which are thought fit for it, according to their destination, Meteorological Observations are to be undertaken and noted down conformably to the scheme adopted at the Conference of Brussels, but with the following restrictions:—

That the specific gravity of the water is not necessarily to be examined daily, but only when there is a fit opportunity to do so.

That it is not made a duty daily to examine the temperature of the water below the surface, but that such is to be done whenever place and opportunity are fit and convenient, and if possible in different depths; and,

That the aneroid barometer is to be used on board the smaller vessels, and where a mercurial barometer cannot appropriately be placed.

The Director of the Hydrographic Office has been ordered to take care of the execution of the above decrees, and, as far as might it be thought appropriate

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to communicate with Lieut. Maury at Washington. Respecting the participation of merchant ships in the aforesaid Observations nothing was decreed, only it was left to the Director of the Hydrographic Office also in this respect to enter into communication with Lieut. Maury.

From this gentleman the Hydrographic Office has at different times received large collections of his Current and Wind Charts, as well as Sailing Directions, to be distributed both to men-of-war and to merchant vessels. The men-of-war have been furnished with these Charts, and they have been distributed to merchant vessels, Danish as well as to a few foreign, on their undertaking to deliver the Meteorological Journals after having been filled up. When the Master of the ship could express himself in English, the journal was written in this language; when it was written in Danish it has been translated into English at the Hydrographic Office. The journals received from the vessels have gradually been transmitted to Lieut. Maury. The last collection sent by this gentleman was received by the Hydrographic Office on the 17th December 1861.

The war in North America, and the interruption occasioned thereby of all the communications which had been brought about by Lieut. Maury with foreign countries for the promotion of Maritime Meteorology, has caused a cessation of the interchange of the objects concerned also with regard to Denmark.

Professor H. Mohn, Royal Meteorological Institute, Christiania.

In reply to your letter of the 7th of May, I have the honour to offer the following remarks :—

The Resolutions adopted at Brussels have been carried out in the Norwegian Navy, by both the men-of-war and merchantmen. The logs have been sent to Washington. The "Abstract Log" has been used on board the men-of-war; the Merchant Service Log on board the merchantmen. A number of Maury's Wind and Current Charts, as well as of Maury's "Physical Geography of the Sea" have been distributed to Norwegian Captains making observations and forwarding their logs to Washington. In our country there has not been any official provision for securing the corrections of the instruments used for the above-named observations. It will not be possible to ascertain the number of the logs sent to Washington. The observations contained in the merchantmen's logs embrace almost all navigated parts of the sea.

The observations have been continued, as I can see from logs now in the possession of the Meteorological Institute at Christiania, up to 1865. In the year 1867 the Norwegian Meteorological Institute issued an invitation to Norwegian Sea Captains to make Meteorological Observations on board their ships. Through the different Shipping Offices in the country the Captains could receive schedules with instructions for making the observations. Since that time there have come into the Institute yearly about 60 logs. From that time the logs issued by Maury have not been in use in our navy.

The grounds for departure from the Brussels Resolutions are therefore chiefly the establishment of the Meteorological Institute. Meanwhile there may also have been other grounds.

In the Royal Navy the observations grew scarce, as the instruments originally purchased grew older and unsuitable, and the observations came to a close at the beginning of the war in America. In the Merchant Navy it was difficult to keep up the observing spirit among the Captains as they did not get any encouragement or instruction from any Scientific Institution at home.

Capt. E. Mouchez, Ministry of Marine, Paris.

I regret to inform you that the Regulations laid down by the Brussels Conference have not been regularly carried out either by our Navy or Merchant Service. Log books were printed nearly similar to the one adopted, and were distributed on board the ships; but the want of success in taking the observations has been principally due to the following causes :—

1. Too much was asked for, instead of limiting the requirements to what was strictly necessary.

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2. The use to which the observations would be put, or how they would be employed after the voyage was not made sufficiently apparent.

And, further, no Observatory or Central Establishment was specially charged with the duty of keeping and studying the Registers.

It appears to me, therefore, that what is wanted is, 1°. a simpler form of Register, and, 2°. the establishment in each Country of a Central Office, whose duty would be to receive all the Registers, and extract their data according to rules to be settled upon, and to give advice as to the manner in which they have been kept.

As soon as it is known that these documents are studied and utilized, no doubt all the Navigators will be eager to take the observations with greater care than is done at present.

Brigadier-General A. J. Myer, Chief Signal Officer, U.S.A., Washington.

I have the honour to acknowledge the receipt on May 20th, 1874, of a communication referring to the action of a Sub-Committee appointed by a Permanent Committee of the Vienna Congress upon the subject of Meteorological Observations taken at Sea. This communication was addressed by you to Rear-Admiral C. H. Davis, Superintendent of the United States Naval Observatory at Washington, with the request that it might be forwarded to the proper quarter, and has been transmitted by that Officer to this Office for reply. The interruptions caused by the war and the changes which have taken place, both in the *personnel* and the duties of the different services since the date of the Brussels Conference, have rendered some delay necessary in order to ascertain as definitely as possible, what had been done in the different Departments up to the present time.

I am able to give you briefly the following facts :—

(1.) The United States at once undertook to carry out the propositions adopted at Brussels. The "Abstract Log" was approved by the Navy Department, adopted, and ordered for use in the Navy, and is at this time used in all naval vessels. Navigators generally were invited to keep the log, and transmit copies at the end of each cruise to the Chief of the Bureau of Ordnance and Hydrography.

(2.) To encourage all Navigators in so doing, copies of the Sailing Directions and of all published results based upon data furnished by them were offered them.

Agreeably with this arrangement of a proposed exchange, a large number of navigators of various flags furnished freely the observations taken by them at sea. These observations were compared, employed in perfecting the work already begun, and in prosecuting researches in Maritime Meteorology. A large number of copies of Maury's Sailing Directions and kindred publications were distributed among the contributors of different nations according to this arrangement.

(3.) In conformity with the Brussels plan, the United States received the co-operation of foreign Powers, who were not ready to discuss the observations of their own vessels, but who were willing to collect and forward them to Washington. Among these were France and the Netherlands; and the vessels of all such co-operative Powers were put on the same footing with American vessels in receiving the Wind and Current Charts, the Sailing Directions, &c., issued by Commodore Maury, many of which are based in part upon such data. This continued up to the commencement of the war in 1860.

(4.) After 1861, though with occasional protracted interruptions, the United States continued to collect maritime data according to the suggestions made at Brussels. The Abstract Logs, filled up upon the vessels of the United States' Navy, are filed in the Bureau of Navigation, whence they are transmitted to the Hydrographic Office of the Navy Department, for such use as may be made of them.

Since the establishment of the Signal Service Bureau charged by law with the observation and report of storms, the duty of displaying cautionary signals at the different ports and upon the sea coasts, and also of furnishing such reports as may be necessary for the benefit of Agricultural and Commercial Interests, it has been one of the duties of this Office to collect from all vessels

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arriving in the ports of the United States extracts from their logs, or other useful data, and also to request assistance from any vessel or officer in collecting such data. The enclosed form * issued in 1871, is one prepared for this purpose. A circular is also enclosed.* The Observers of this Office located at the different Branch Offices established at the different ports have also been instructed to visit vessels in the ports and procure useful information. The Office has also furnished instruments for use upon vessels furnishing reports to this Office.

In exchange for such courtesies the facilities of the Signal Service Offices in the different cities for comparison of instruments, obtaining specific information in reference to the weather past or present, the use of their daily telegraphic record, &c., are extended to the Officers of any vessels of any nationality that desire to avail themselves of them, and upon request of any Officer corresponding with the Office, any publications of the Office are furnished to him free of charge.

In its exchange with other Offices this Office is always ready to furnish upon their request, data in its possession relating to particular storms occurring either upon the land or sea, or to enter upon wider exchange in pursuance of the suggestions of the Vienna Congress.

The system of Simultaneous Observations adopted at that Congress requires, to complement it, a system of coincident observations extended as widely as possible at sea.

E. Quetelet, Royal Observatory, Brussels.

With respect to Maritime Meteorology, I have seen the Director of this Department, at the Ministry of Public Works, and he thinks that only a few results exist. To make the necessary inquiries, he requested me to apply to the Ministry of the Interior. I have not yet received an official reply, but I believe you can only reckon on very little. We have no Navy, and the captains of the Merchant Service generally care very little about scientific questions, especially when anything would thereby be added to their work. A reform must be introduced if useful results are wanted.

Capt. M. Rikatcheff, Imperial Russian Navy, Central Physical Observatory, St. Petersburg.

Mr. Wild asked me to answer the questions contained in your letter of the 7th May 1874.

Our Navy is provided with Meteorological Journals, Instructions, and Instruments by the Hydrographic Department. The journals containing observations are returned to the same Department.

To be able to answer you with sufficient authority I have seen some of the last Meteorological Ship Journals, and I had an interview with Vice-Admiral Zelenoy, who has been 15 years the Director of the Hydrographic Department, and left this duty only a few days ago. I divided your questions into six points, and in the name of Mr. Zelenoy, I am authorized to answer as follows:—

1. The thermometers on board ship have not been provided with another scale in addition to Reaumur's, as required by the Resolutions of Brussels Conference, because (*a*) if a thermometer were to have two such similar scales as Centigrade and Reaumur, one would be often read instead of the other; (*b*) the conversion of degrees Reaumur into Centigrade is so easy, that it is not judged necessary to have two scales together, only in order to accustom observers to the use of the Centigrade; (*c*) to avoid a considerable and useless expense.

2. The barometers have not been compared since 1853, and corrections of instruments generally are not determined, because there is no Office or official person who has the charge of all maritime observations.

3. Anemometers are not in use on board ships, because no experiments have been made with them, and there was no Office, as mentioned above.

4. Ships for long voyages are provided with hydrometers, and occasionally observations are made with them.

5. The meteorological observations have hitherto been made exactly in the form recommended by the Brussels Conference, because the opinion of the Director

* Not printed here.

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of the Hydrographic Department was, that nothing should be changed without another Resolution of a second Maritime Conference, and because there was no Office which had to discuss the Journals and propose any change.

6. Some of the Ship Meteorological Journals have been sent to Lieut. Maury, in Washington, and afterwards to the Office of Admiral FitzRoy. The Maritime Meteorological Observations are not discussed and utilised in our country, and Journals are not even sent regularly to any office abroad, because we have no Office for Maritime Meteorology, and because, after the death of Admiral FitzRoy, nobody asked the Department for Journals.

You ought not to be astonished, Sir, if from these answers you see that the greater part of our Maritime Meteorological Observations lie dormant till now. The Director of the Hydrographic Department is so much charged with other business, that it is not possible for him to undertake the direction of the whole question of Maritime Meteorology.

Many times, and especially in the year 1862, he asked the Government to institute an Office for Maritime Meteorology, but it was never done, and only in this year, on the recommendation of the Imperial Academy of Science, a Commission has been appointed to prepare a project for such an Office.

Dr. R. Rubenson, Royal Meteorological Institute, Stockholm.

After the receipt of your last letter of the 7th May I made inquiries into the questions contained in it, and can, unfortunately, give but very little information about the state of Maritime Meteorology with us. From what I have been able to learn from persons acquainted with these matters (Peterson died long since), so-called "Abstract Logs," were distributed just after the Brussels Conference, both to Captains in the Navy and Masters of Merchant Ships. These log-books were, by the care of the Royal Academy of Science, translated into English (some Captains kept their Registers in English) and sent to Maury, at Washington. At the outbreak of the American war these transmissions ceased spontaneously, nevertheless the observations have been continued to the present time on the same plan in our Navy, and these Meteorological Registers are deposited in the archives of the Central Meteorological Institute. Their number, however, is not sufficient to allow of their being worked up there.

I have been unable to get any further information about the Observations in the Merchant Service. I presume, therefore, that the whole system in that Service has ceased to exist.

Although this matter belongs to my Department, I have not yet been in a position to arrange the system of observations, but I should consider the Resolutions of a future Congress for Maritime Meteorology as a welcome opportunity for directing attention to this subject here, and shall endeavour as far as in me lies to contribute our share to the common work at sea.

Commodore R. H. Wyman, U.S.N., Hydrographer, Washington.

Replying to your letter of the 7th instant referred to this Office, I have the honour to state that the Resolutions adopted at the Brussels Conference were carried out in this Country up to the commencement of the late war.

The Abstract Logs were printed and issued both to naval and merchant vessels, but are not now issued to either. The Log now in use in the Navy of the United States is substantially the same as far as its Meteorological Records are concerned, as the Log recommended at Brussels—we employ the Howard Cloud nomenclature and a scale for wind-forces differing not materially from the Beaufort scale.

I send you herewith a copy of the Meteorological Journal recently introduced from this Office.

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Appendix C.

Remarks by Capt. Toynbee, in answer to Questions I. to VIII. of the Programme; followed by Extracts from the Written Opinions of other Correspondents.

Captain H. Toynbee, F.R.A.S., Marine Superintendent, Meteorological Office.

I. OBSERVATIONS.—We in this office have thought it necessary to depart slightly from the form of the Brussels Log, and I have drawn up a form which is the result of my experience of eleven years as an Observer at sea, and of seven as Marine Superintendent of this Office.

For convenience of reference, I shall give in the margin the numbers of the Columns of the Brussels Log, stating the changes proposed, and my reasons for them.

Date and Positions by Observation and Dead Reckoning.—These remain the same, only we have made it clear at the head of Column 1 that we wish for Civil Time, and we have rejected the 9 a.m. and 3 p.m. entries, which give undue weight to the day hours. These entries would also prevent our getting observations at four-hourly periods, for few men will observe at 8 *and* 9 a.m. or at 3 *and* 4 p.m. Columns of Brussels Log. Cols. 1 to 6.*

Current.—This has been transferred to the Remarks, as the direction and rate of Current is generally only found once in 24 hours. When opportunity offers for finding the current more frequently, the result should also be given in the Remarks. In the space previously occupied by "current," we have introduced "*true* course and distance by Log every four hours," as suggested by Professor Buys Ballot. This is very useful work to the Navigator, who should know his ship's position each four hours, and it helps the Meteorologist to find the latitude and longitude of the position in which each observation was taken. It is not, however, considered absolutely necessary, as explained in the new Instructions. Cols. 7 and 8.

Magnetic Variation Observed.—Instead of this we have "Total Compass Error," or variation and deviation combined. These are the data which Navigators usually enter in this column, therefore it should be so headed. Next to the compass error we give a column 10 for "ship's head," and degrees of Heel to Port or Starboard. From the compass error and direction of ship's head, together with the deviation from one of the forms at the commencement of the Log, which it is supposed will be filled up, the *Variation* may be deduced if required (always remembering that the deviation is liable to change with geographical position), and even though the total compass error may not be recorded, it can be found if we have the direction of the ship's head, and the deviation recorded in the tables, always supposing that each ship has a variation chart or table. By this means the *observed* direction of the wind can be converted into *true*, which latter result is the chief use of compass error to Meteorologists. Col. 9.

Direction of Wind.—(This comes in our column No. 11.) We have added "at the time of observation" which we prefer to an estimate of what has prevailed for the last eight or even four hours; and we ask for it every two hours. It is believed that, as a rule, seamen only record the wind which was blowing at the time of actual *observation*, and a fact is preferred to a doubtful estimate. In synoptic chart work *the estimation* of wind for a certain number of hours is very objectionable; for instance, in our discussion of the Meteorology of the part of the Atlantic, north of 30° N., we frequently found that ordinary ships' logs which give the direction and force of wind for each hour, were much better than our own logs for fixing the time at which a certain change of wind reached a ship. Col. 10

The proposed method of giving the direction and force of wind at the time of actual observation, every two hours, and also any important changes which may intervene between the two-hourly observations, as well as the direction and force

* See the corresponding columns in the reduction of the proposed form of Log at the end of Appendix D.

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Columns of the Brussels Log.

of squalls, seems to meet the present requirements of Maritime Meteorology. If a squall is blowing at an ordinary time of observation, the direction and force of wind between the squalls should be recorded, and the direction, force, and duration of squalls should be given in the Remark Column.

Col. 11.

Wind Force.—(See our column No. 12.) This is by Beaufort's scale, and is also asked for each two hours, *at the time of observation*, a record which (as in the case of direction) is considered much more satisfactory than a rough estimate for eight or even four hours. Here it may be well to repeat that if the weather is squally, the direction and force between the squalls should be given, and the duration, direction, and force of squalls should be entered in the Remark Column. When squalls are frequent their general character should be given.

I do not think that a cup anemometer can be successfully used at sea, having tried one for a voyage, but should like to have a small fan wheel tried by an experienced Captain.

I think that Beaufort's Scale, which expresses the force of wind by figures, words, and the speed of his standard ship (a well-conditioned man of war), or the amount of sail which she could carry, is the best at present devised. As the "double topsail yard" rig is now very common, I propose to give also the equivalent amount of sail which Beaufort's ship would carry if she were so rigged, all other qualities being the same. This only affects the forces 6 to 10, inclusive.

Cols. 12 and 13.

Barometer height and attached Thermometer.—(Our Nos. 13 and 14.) We have slightly altered the headings and asked for the height of the cistern above the sea. For the use of seamen I would certainly return to reading barometers to hundredths of an inch, and would make the vernier as distinct as possible. Many officers cannot read to thousandths, and others twist the barometers about so as to get them into a position for easy reading (as it is difficult to bring both sides of the circular vernier and the surface of the quicksilver in a line), thus causing the quicksilver to rise in the tube.

Thermometers, Dry and Wet Bulbs.—(Our Nos. 15 and 16.) I think all ships which carry our instruments should be asked for these observations. Our Square 3 work shows their value. The thermometers should be read to tenths of a degree, the division being easily done by the eye.

Col. 16.

Forms and Direction of Clouds.—(Our Nos. 17 and 18.) We have divided these data and give them in two columns. In No. 17 we give the names of Lower Clouds; in No. 18 the names of Upper Clouds, and direction *from* which they move over the sun, moon, or stars. If the direction from which *Lower* Clouds move differs from that of the wind, we ask that that fact may be recorded in the Remarks.

In our Square 3 work the eastern and western strips of the charts, as well as Tables 6, 7 and 8 for each month, and the Remarks following them, show the use that we have made of Cloud data.

Col. 17.

Proportion of Sky Clear.—(Our No. 19. *Proportion of Sky clouded.*) It matters little whether we give proportion of Sky or Clouds, but as we have the Amount of Cloud in full use, I think it well to continue it.

Col. 18.

Hours of Fog (A), *Rain* (B), *Snow* (C), *Hail* (D).—(Included in our No. 20, Beaufort's Weather Notation.) Beaufort's letters which represent these states of weather should be preceded by a figure showing the number of hours they had existed since the last observation.*

Col. 19.

State of the Sea.—(This column we have expanded into two columns, Nos. 21 and 22.) These give the direction from which the sea comes at the time of observation, recording when it is confused, and when it is only a swell or swells. No. 22 shows the disturbance of the sea by figures, which are explained on the same page with Beaufort's Notation: They are adopted by the land branch of this Office in its Telegraphy.

Cols. 20 and 21.

Temperature and Specific Gravity of Sea Surface.—(See our Nos. 23 and 24.) They both give interesting results in our Square 3 work. I think the degrees

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* The London Conference decided that it is desirable to retain Column 18 of the Brussels Log, but that the use of Beaufort's Notation in one column may be continued by those countries accustomed to it. The latter method has been continued in the English Log, and it is the only case in which there is a difference between the Log adopted by the London Conference and that given with this Report, which is the one proposed by Capt. Toynbee.

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of the thermometer, and the divisions of the hydrometer are easily divided into tenths by the eye, which makes their readings more exact. Columns of the Brussels Log.

Temperature at Depths.—This observation should, it seems to me, be left to men-of-war, or ships specially fitted for the work. We supply a self-recording thermometer, and copper case with a valve at each end, to observers who offer such work, with the object of trying the temperature at small depths, as they may sometimes show that cold water of lower density, may overlie warm water of higher density, &c. &c. Such observations are only occasional, and do not need a special column, but should be entered in the Remarks. Col. 22.

State of the Weather.—(See our No. 20.) The contents of this Column together with those of No. 18 are combined in our No. 20. Col. 23.

Remarks.—(See our No. 25.) A few suggestions as to the most important Remarks are given at the head of the Column, and they are more thoroughly explained in our Instructions. Col. 24.

Experience has proved that it is most important for each Log to be carefully examined as soon as it is received, so that any questions found necessary may be asked of the Captain who kept it, before he sails again. See the "Form for testing Logs" in each filled-up Log, of which the following is a reduced blank copy:—

FORM FOR TESTING LOGS.

No. of Log. Date. Nature of Voyage. Character. Captain. Observer's Rank (hours he observed). Ship.	Commencing — Ending From — To For whole of Log Keeper of Log Wood or Iron — Steam or Sailing
	Instruments.
Barometer.	No. Height of Cistern feet.
Thermometers.	Sea surface No. — Dry Bulb No. — Damp Bulb No.
Hydrometer.	No.
Entries. Character.	Hours when observations are given? Hours taken for extraction? Did ship pass to eastward of Cape Verd Islands on outward passage? Are there too many entries of "Do." instead of observations?
Ship's Positions. Character.	Are observed and Dead-Reckoning positions given throughout? Is there any evidence of positions being good or bad? Is Dead-Reckoning longitude carried on from last land seen?
Currents. Character.	Given by Captain? — Are they correctly calculated? Are data regularly given? — Do results seem probable?
Sea Temperatures. Character.	Average number of observations daily? Name tests. Obs. read to degrees or tenths.
Specific Gravity. Character.	Average number of observations daily? Do they range lower in Doldrums?
Compass Errors. Character.	Are there data for obtaining the actual compass errors? Does the variation agree with Admiralty chart?
Ship's Head. Character.	Is it generally given?
Winds. Character.	Direction: Is it given to 32 points of the compass? „ Are changes and their times carefully given? Force: Are changes and their times carefully given? „ Does it agree with distance run? „ Are the direction, force, duration, and veering of squalls given?

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Form for Testing Logs—*cont.*

BAROMETER. Character.	Is daily range regularly shown in tropics? Does pressure decrease when approaching Equatorial Doldrums? Does pressure increase when leaving Equatorial Doldrums? Does the barometer rise or fall in accordance with Buys Ballot's law? Is there evidence of repetition or interpolation? Is attached thermometer always given? Does barometer "pump" much?
DRY AND DAMP BULBS. Character.	Are they in the open air, showing diurnal range? Any signs of being in sun? Is there a fair difference ranging with weather? Obs. read to degrees or tenths.
CLOUD. Character.	FORM: Well given? Regularly given? Simple and compound well separated? AMOUNT: Cloud or clear sky? Scale 0 to 10? DIRECTION OF UPPER: From or to?
WEATHER. Character.	Is it fairly represented? Is the entry "Do." used frequently? Can it be got from remarks?
REMARKS. Character.	Is state of sea given? Are any interesting facts given? Are they full or scanty?
HYDROGRAPHICAL NOTICES.	Give their dates?
DIAGRAMS.	Are they neatly drawn?

The character of each style of observation is recorded under the word "Character," and the general character of the whole log is deduced from these and recorded on the upper part of the testing form. The greatest weight being given to wind, barometer, and thermometer observations.

On the back of the testing form are the following tabular forms for testing the calculation of current, and for comparing the recorded force of the wind with the speed of the ship, so as to show whether the force seems to have been under- or over-rated.*

OUTWARD PASSAGE.						
Date	CURRENTS.		WIND FORCE.			
	Dif. Lat.	Dep.	Distance in. Lat.	Distance in. Long.	Distance run.	Knots per hour.

HOMEWARD PASSAGE.						
Date.	CURRENTS.		WIND FORCE.			
	Dif. Lat.	Dep.	Distance in Lat.	Distance in Long.	Distance run.	Knots per hour.

II. INSTRUMENTS.—I think the instruments used by this Office are very good. So long as they *are* good, and properly compared with standards, it does not seem to matter much what system of scales is used, and I should prefer those to which the observers are well accustomed, so as to avoid errors as much as possible. I think that there would be great difficulty if we attempted to change the scales to which our Captains have become accustomed, in fact my chief desire is to make the work more easy if possible, with the object of getting a larger number of observers.

* It is easy to discover when the force is *under-rated*, as few merchant ships would sail faster than Beaufort's typical man-of-war; but the question as to *over-rating* requires very great judgment, as we cannot know the individual qualities of each ship, and the speed of a ship frequently decreases as the sea rises, although this is generally in consequence of the wind freshening.

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III. INSTRUCTIONS.—Instructions must be modified so as to meet the customs of various countries, but they should so far agree as that the results of Observations in different countries may be compared and combined if requisite. I have recently revised our Instructions to adapt them to the form of log now proposed.*

IV. OBSERVERS.—Our present plan of supplying instruments and logs is good, but some Captains cannot undertake so much work, and as we need a large number of Synchronous Observations for daily charts, I am inclined to propose that we offer to compare the instruments belonging to certain ships, to supply their Captains with Rough Books, and to get them to record a few more instrumental observations than they have been in the habit of doing: then at the end of the voyage to ask for their ships' logs, or even for the Rough Books properly filled up. By this means we should be brought into direct communication with a larger number of Captains, and might increase the number of first-class observers, who take our instruments and keep a separate log for us. We might try this method for second class observers with all ships that trade in the North Atlantic, with the object of connecting the American and European daily land observations.

V. CO-OPERATION OF THE ROYAL NAVY.—This Office does not receive many Meteorological Logs from the Royal Navy, and in some cases they are not so good as might be hoped for. In cases where the Captains and Navigating Officers take special interest in the work, first-rate registers are produced. It is hoped that means may be devised by which every ship in the Service will record first-rate meteorological observations, for at least the four-hourly periods, and in logs which may be deposited in this Office, as we wish to perform part of the discussion of the observations in the logs themselves, a practice for which the Royal Navy logs are not adapted, and if they were, such disfigurements could not be permitted.

VI. DISCUSSION.—Discussion naturally divides itself into two branches:—

1st. Meteorology requires the monthly, or other, means of various data for certain parts of the sea. These are deduced from observations spread over a large number of years, and can be discussed after the method of our extracting books if the data are required in 1° squares. This method is explained in the Report for 1867, and in the introduction to our Square 3 work.

2nd. Synoptic work, or daily charts at a given hour; for this the method followed in drawing the charts for our "Discussion of the Meteorology of the part of the Atlantic lying North of 30° N., &c.," seems to be the most suitable, though probably the stereographic projection would be better for the charts than that of Mercator.

VII. SUBJECTS OF INQUIRY.—DIVISION OF LABOUR.—If division of labour means breaking up the meteorological subjects of a district and dividing them amongst different nations, I do not approve of it, as one part of the data throws light on another: for instance pressure and temperature are related; also winds, currents, and sea temperature (see our Square 3 work). But if division of labour means that one nation has a large mass of observations for a certain district, and wishes to make them more complete by combining with them those of another nation, then I think it is good; and, as in this case one nation might be called upon to supply much more data than another, it seems well to keep to the custom of this Office, and to let each nation pay for the copying of the data it asks for.

The methods of dealing with meteorological data are so varied and progressive, that we can hardly hope to bind all countries to the same; but if the best method could be devised for dealing with monthly or other means, and another for synoptic data, it would be well that all countries should follow them. In all cases it might be well to give the data in such a form as that they may be easily combined with other observations. It would also be well for the Heads of Departments to communicate with each other before commencing new work, and to ask what available data each has on the special subject or district.

VIII. SAILING DIRECTIONS,—or "best routes," seem to be the natural result of Marine Meteorology, though I should be inclined to give not merely the best routes, but also the data from which they are deduced. Our Square 3 work enables the Navigator to form an independent judgment, which he could not do if

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* See Appendix D.

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we merely worked out the best routes by averaging the number of days employed by different ships in passing through the different routes. It seems necessary that Meteorology should give the *reasons* for a certain route as well as the fact that it is the best. This is what has been aimed at in our Square 3 work.

In dealing with the data of Square 3, it was felt that as seamen had been asked to record certain facts, some of which were not Meteorological, those facts ought to be dealt with, otherwise it would be fair for them to say,—Why ask for such facts?

A. Buchan, Secretary, Scottish Meteorological Society, Edinburgh.

I.—*Observations.*

Cols. 10 & 11. A simple pressure anemometer, registering the maximum force of the wind is recommended for the purpose of arriving at some rough approximation to the force of the wind at sea, and the pressure exerted on sails. An anemometer on board ship will not give results sufficiently trustworthy for strictly meteorological purposes.

Beaufort's scale should not in its present form be made universal; but the pressures represented by the figures might be altered so as to represent a regularly graduated series of pressures when it could be recommended for general adoption. It is perhaps unnecessary to add, that the strength of the wind at sea should be referred not to velocity but pressure.

Cols. 12 & 13. If the barometric readings are carried to two decimal places, such observations should be declared to be satisfactory, but three decimal places might be recommended.

Cols. 14 & 15. The dry-bulb should be declared to be satisfactory, but both dry and wet bulbs should be strongly recommended, and particular directions given as to a good position for these instruments.

NOTE.—The errors of the thermometers should not exceed 0°·3.

Col. 16. There should certainly be two columns for clouds, one for the Lower and another for the Upper Clouds.

NOTE.—Observations of the Upper Clouds at sea are of the utmost importance, particularly in view of their connexion with the question of the advance of storms on Western Europe from the Ocean.

Col. 17. Yes, by all means.

Cols. 18, 19, & 23. Retain in separate columns.

NOTE.—Should state smooth, rough, ground swell, with approximate height of waves; and in cases of ground swell without wind, the direction in which the waves come should be stated.

Cols. 20, 21, & 22. Retain these also as separate columns.

Notes on Observations:—

1. The force and direction of the wind should be entered as at the hour of observation, and not the force and direction which has been most prevalent during the four (or eight) preceding hours. The latter should go into "REMARKS" column together with the times when storms came on and took off.

2. All barometers and thermometers should have one scale only, and not two scales as recommended. Two scales engraved on one instrument lead to errors of observation.

3. It is assumed that such nice questions as the relation of wind-force to the barometric gradient do not fall within the scope of Ocean Meteorology.

II.—*Instruments.*

In addition to the ordinary marine barometer there should be an aneroid which could be used as an interpolation instrument.

Particular directions should be issued as to the protection of the thermometers with the view of securing, so far as attainable, uniformity among air-temperature observations at sea.

Since the introduction of Metric and Centigrade systems for general use at sea is not reasonably possible, the English barometer and Fahrenheit's thermometer should be retained.

III.—*Instructions.*

Yes, and all steps should be taken by extended experiments and observations where required to prepare a general form of Instructions, which will secure uniformity in methods of observation.

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IV.—*Observers.*

It should be seen that the instruments are of patterns which are recommended, that their errors at different points are known, and that they are periodically compared with standard instruments.

Whilst it is desirable that the Central Establishment *lend* in the most liberal manner to observers the instruments which are required, it is for various reasons most desirable that owners of ships, Captains, and others who may be observers, be invited and encouraged to procure instruments for their own use, it being in all cases clearly understood that such instruments must previously and thereafter periodically be compared with standard instruments.

V.—*Co-operation of the Royal Navy.*

Generally, as indicated under the third Resolution adopted at Leipzig and confirmed at Vienna. In certain cases the services of the Royal Navy might be made available in collecting meteorological data from the less frequently traversed parts of the ocean, the Meteorology of which it is most desirable to know.

VI.—*Discussion.*

In the discussion of the observations two objects should be aimed at:—(1) That the results of, say, the barometric observations represent as approximately as possible the *mean* atmospheric pressure of the Square or Sub-Square discussed, or furnish the data for arriving at it; and (2) that the results be printed in a form so that the results of future observations could be readily incorporated with them without the necessity of again discussing the old observations. Towards securing these objects it is proposed that the results of each Square's observations be printed in full as follows:—

MEANS OF SQUARE No.

Hour.	Mean Barom. at 32° and Sea level.	No. of Obs.	
2 a.m.			Similarly the means of Temperature of Air and Sea-Surface.
4 „			
6 „			
8 „			
9 „			
10 „			
Noon			
2 p.m.			
3 „			
4 „			
6 „			
8 „			
10 „			
Midt.			

In addition to the above, unusually low and unusually high readings should be detailed.

In squares and sub-squares, where numerous observations have been made, this degree of fulness in the published results is less imperative, though it is very desirable in point of scientific accuracy that it be adopted in all cases. But in squares and sub-squares, where comparatively few observations have been made, it is absolutely indispensable that the observations be grouped and arranged and the results published as above, it being obvious that *means* deduced from such observations, uncorrected for daily range, will give results which are not comparable with each other, and which, being misleading, will prove worse than useless.

It is scarcely necessary to add that it is yet premature to deduce daily range tables for pressure and temperature, the requisite number of observations not having been yet collected. Till this be done it is wise to publish the results uncorrected for daily range.

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VII.—*Subjects of Inquiry.*

Obviously the division of labour as regards Subject of Inquiry can only be brought about by mutual arrangements entered into among the Collecting and Discussing Establishments themselves. A strong hope is hereby expressed that these Establishments will effect some such arrangements, the repetition of work over definite regions with reference to the area to be investigated having been already declared by the Congress at Leipzig and Vienna to be indefensible.

J. C. de Brito Capello, Observatory, Lisbon.

I.—*Observations.*

Cols. 10 and 11. I think that it is possible to construct an anemometer suitable to observe the velocity of the wind, but much attention must be given,—

1. To the placing of the instrument so as to be free from the influence of the sails, &c.
2. That the axle of the instrument keeps the most advantageous position to give trustworthy indications.
3. To the manner of discriminating the absolute velocity of the wind from the total velocity indicated by the instrument.

I think that it is possible to construct anemometers of the system of the *air meter* of Casella, with a weathercock to keep the plane of the movement of the paddle wheel normal to the direction of the wind.

The use of the Beaufort scale can hardly be made universal, as two ships according to their construction bear the same wind in a very different manner. And how can one employ this scale in a steam ship?

I would prefer the establishment of an universal numerical scale, similar to the scale employed to denote the force of the wind in the Continental Meteorological offices.

I present the following table only as an example:—

0. Calm.
1. Very light.
2. Light.
3. Moderate.
4. Fresh.
5. Strong.
6. Very strong. Heavy.
7. Violent. Storm.

The intermediate gradiations may be denoted with the two next numbers, as: 1.2, 4.5, &c.

II.—*Instruments.*

In order to accustom the English Observers to the Metric scale, I propose that in the barometer the two scales (inch and metrical) should be side by side. With this precaution and some years of practice it would be possible to adopt universally the Metric scale for the barometer and the Centigrade scale for the thermometer.

III.—*Instructions.*

I think that very detailed Instructions must be given to the Observers, especially with regard to the placing of thermometer, in order to give the most approximate temperature of the air.

VI.—*Discussion.*

The mode of discussing the observations used in the London Meteorological Office is the most sure and methodical, but it is very troublesome.

There are some more easy methods, but they are not free from inconvenience; one of these, very ingenious for the classification of the observations according to the latitude and longitude, in use (I think) in the Meteorological Institute of the Netherlands, consists in cutting the *abstract log* in strips, and placing every strip in the compartment corresponding to its latitude and longitude;

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with this method the work is much facilitated, but the *abstract logs* are lost.*

There is yet the graphic method which has many advantages, mixed however with some inconvenience.

This method consists in writing on two large sheets of paper, where a degree is 0.1 or 0.15 metre long, the observations of a month denoted by conventional symbols. In one of the sheets we inscribe, at the latitude and longitude of the observation, an arrow denoting the force and direction of the wind, another different arrow denotes the direction and rate of the current, and the principal accidental phenomena, such as rain, lightning, thunder, the proportion of the sky clouded, fog, &c., are denoted by symbols. In the other sheet and at the same place we write the readings of the barometer, temperature of the air, temperature of the water, magnetic variation, specific gravity, &c.

When all the observations are inscribed, those in a square degree are combined, except the currents, and a mean obtained which is the only entry on the final map. This map in a smaller sheet contains many of the original sheets. To complete the monthly map we inscribe in every square the number of the variable winds, calms, barometrical and thermometrical observations, percentages, &c.

VII.—*Subjects of Inquiry.*

There must be a Central Office charged with continuing the construction of the Charts according to the system of the Meteorological Office, with the modifications that experience will suggest, and the Conference think necessary to introduce.

To this Central Office, which will be surely the London Meteorological Office, all the Directors of Meteorological Maritime Observatories will send summaries of their observations, already classified as to the geographical positions, and arranged according to the plan now adopted. The Central Office can even furnish the blank forms so as to have more uniformity in the summaries. These summaries must not prejudice any other study or publications that every Observer will make.

The Offices which send their summaries should receive in exchange some of the general charts published by the Central Office.

C. Meldrum, M.A., Secretary, Meteorological Society, Mauritius.

Previously to the Conference held at Brussels the Meteorological Society of Mauritius had adopted a form of "Abstract Log," which has been adhered to since.

The main ground for not adopting the Brussels "Abstract Log," has been the difficulty of getting shipmasters to take the required observations. Only a small number have kept that Log for the Society.

I.—*Observations.*

Cols. 10 and 11. It may be possible, but I do not think that any means now exist for obtaining accurate observations of the pressure or velocity of the wind at sea.

The Beaufort scale is, I think, objectionable, on the ground that the numbers do not express the relative velocities or pressures of wind, a strong breeze being 6 and a hurricane only 12. It is, I think, possible to adopt a scale, the numbers of which, while referring to the amount of canvas a vessel can carry, would give a nearer approximation to the relative force.

Cols. 14 and 15. No. I think that any observations carefully made on board ship should be received, even if they were only the positions of the vessels and the directions of the wind, with remarks on weather.

Col. 16. The *same* nomenclature of clouds should be adopted. Particular notice should be taken of all the strata seen.

Col. 19. The state of the sea might be represented by symbols.

IV.—*Observers.*

Officers of the Mercantile Marine should have to undergo an examination as to their knowledge of the construction and use of the barometer and thermo-

* I have since found that this is an error. It is a copy of the observations in the Log which is cut up, so that the Log itself is not lost.—J. C. DE B. CAPELLO.

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meter at least. It would probably be considered a hardship to compel the use of a certain class of barometers and registers on board ships making distant voyages, but recommendations might be made and circulated. It is in my opinion very important that *all* observations carefully made on the winds and weather at sea should be received at the Central Establishment.

VIII.—*Sailing Directions.*

I think that a Scientific Institution for advancing Meteorology should confine itself to obtaining reliable observations and to discussing them, leaving the practical application of the results to those most interested.

Captain M. Rikatcheff, Imperial Russian Navy, Central Physical Observatory St. Petersburg.

I.—*Observations.*

Cols. 10 and 11. The column for direction of wind by compass should be retained, because this value is given by direct observation, and is therefore less liable to error. We are also accustomed to give the direction by compass, therefore this must be given as well as the true direction, to remove the doubt as to whether the direction of wind has been corrected for compass error. We propose also to retain the column for force of wind by Beaufort's scale. Hitherto it is the only scale used for noting the force of wind, and, besides, it is necessary to have the means of comparing this scale with the velocity of the wind, which I propose to measure with an anemometer, and to enter in the next column. In my article on this subject in the Austrian Journal for Meteorology I have given my reasons for thinking that this element is one of the most important in practice as well as in theory. I think that it is not difficult to set up an anemometer on board a ship. In any case the result thus obtained would be more certain than estimation by Beaufort's scale. I agree, however, that before the introduction of this method, some experiments should be made. We erected an anemometer on board the ship "Wsadnik" last autumn, but, unfortunately, we have not yet received the result of these observations.

I propose to introduce two more columns for the *true direction* and the *true velocity* of the wind. This direction and velocity should be corrected for the magnetic variation and the deviation of the compass as well as for the ship's way, *i.e.*, we propose to give the absolute direction and velocity of the wind and not the apparent direction and velocity which depend on the progress of the ship. It is almost useless to say that the correction due to the variation and deviation of the compass is indispensable, for the deviation is an element peculiar to each ship, and varies with the direction of the ship and with the change of latitude, and the magnetic variation is not only very different in different latitudes and longitudes, but also varies at the same place with the time.

As to the correction due to the progress of the ship, it is also very important and I think indispensable, if we wish for an exact idea of the distribution of the atmospheric currents. A wind whose velocity is 30 to 40 kilomètres an hour is strong enough to give to a ship, having the wind abeam, a velocity of 15 to 20 kilomètres, which gives a difference between the true direction of the wind and the direction observed on the ship a very considerable value.

I think that if a well adjusted and verified anemometer were given to the Captain of a ship he would very soon accustom himself to this instrument, and would very soon find it as useful and interesting to observe as the other meteorological instruments. It is improbable that after an experiment of some months there would be any opposition on the part of the Captain to make the anemometrical observations.

I am of opinion that it would be better to give the observations at the moment of making them than to estimate the prevailing wind during the past eight hours.

Col. 18. A column giving the amount of rainfall should be added. I see no impediment to erecting a rain-gauge on board ship, and the data will be most important for Meteorology. We are completely ignorant of the amount of rain which falls over the ocean in the zones of the Trade Winds and in the zone of Calms.

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Col. 19. This column may be retained. I propose to denote the state of the sea by the words "calm," "swell," "rough."

The figures 1–2 by the side of "swell," and 1–4 by the side of "rough," will indicate the degree of sea disturbance.

Captain A. Schück, Hamburg.

The suggestions contained in this letter have been carefully considered, but it is not thought necessary to print them. The suggestion that Beaufort's scale should be extended so as to suit the modern rig of vessels has been carried out in Resolution 10.

Baron von Wrangel, Hydrographer, Nicolaief.

The Resolutions of the Brussels Conference have been carried out in Russia so far, that every man-of-war on a long commission, and every merchant vessel desiring it has been supplied with the "Abstract Log" and the instruments necessary for observations. As to the observations, they have been made in an adequate manner only on board a few of those ships, whilst on board other ships many of the columns were left blank, or what is worse, have been filled with imaginary figures.

The chief reason of this fact is, that too many observations were required and the bad choice of the hours. In our Imperial Navy as well as Merchant Service, the best hours are those of the change of watch, viz. 4 a.m., 8 a.m., Noon, 6 p.m., and Midnight.

I.—*Observations.*

Cols. 10 and 11. I do not know of any means by which an anemometer could be made trustworthy on board ship. The estimation by Beaufort's scale (or the 10 numbers of Continental Meteorologists) will give still a better, although approximate, idea of the force of the wind. Up to No. 7 of the Continental Scale sailors will seldom disagree in the estimation, whilst an anemometer may show in one part of the ship twice the velocity it shows in another, not to speak of the practical difficulties in calculating the correction for ship's way, &c. It will be very useful to make experiments in that direction, but I think it as yet impossible to introduce anemometers as instruments for general use at sea.

Cols. 14 and 15. A column for dry and wet bulbs should be left, but these observations should only be recommended, and not required, as they are of less importance than barometer, wind, and weather. Besides it is impossible to find a spot on board where the thermometer would always show the real temperature of the air. I have found that the readings of two thermometers hanging quite free and *in the shade*, one in the aft, the other in the forepart of the ship, or on the weather or the lee side may differ 7° Fahrenheit; on board a steamer, in a calm, the thermometer suspended over the forecastle will always show a great deal less than over the poop or the bridge. As Meteorologists want to know the temperature of the air and not of the ship, it is very important not to have the thermometer in a fixed position, but to suspend it, before the observations are made, at the weather side and in the shade. There is no difficulty in observing the wet bulb as well as the dry if a so-called travelling psychrometer, as made by Kappeller in Vienna, is used. It consists of two thermometers turning on a hinge. When not in use the dry bulb is protected by a copper cap, screwed on the thermometer. A similar cap on the wet bulb contains the water, and when unscrewed can be pulled down to a certain distance from the bulb. This instrument can easily be suspended at any place on the weather side and in the shade before the observation, and put away afterwards; besides it is not in constant danger of being broken.

Cols. 18 and 23. Instead of the two columns, one headed "Weather by Beaufort Notation," should be substituted.

Col. 19. State of the sea should be given at the utmost in five gradations, whether by numbers or by conventional signs, seems indifferent.

Cols. 21 and 22. Specific gravity and temperature at depths cannot be observed on board of all ships; if it is done it can be put in the column for "Remarks." The use of the hydrometer adopted by the Brussels Conference is rather difficult, particularly with a rolling ship, when the small weights will easily

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fall into the water, &c.; of all the hydrometers I have seen, by far the best are those furnished by the "Ministerial-Commission zur Untersuchung der deutschen Meere," Kiel. The pattern called "Normal Gebrauchs-Areometer" is handy and, although made of glass, does not break very easily. The error amounts only to $\pm 0{\cdot}0002$ of specific gravity.

II.—*Instruments.*

It seems to me by far the easier thing to introduce even now everywhere on the Continent the inch scale, than to introduce the Metric system for general use at sea, not only because the number of observers in every part of the world using the English scale is so very much larger than the number of observers using the Metric scale, but also on account of the great and daily importance which the barometer has for the seaman, who is accustomed to attach a certain meaning to the readings of his inch instrument, and will less easily be induced to part with it than the majority of observers at land stations.

IV.—*Observers.*

All the instruments should be verified at the Central Establishment, but I do not think it necessary that they should all be its property. Many observers prefer using their own instruments, and if these are good there seems no reason to increase the expenses of the Establishment.

V.—*Co-operation of Royal Navy.*

In order to secure the valuable assistance of ships of war in collecting meteorological data, it seems advisable not to enforce the making of observations, but to make it a voluntary service as it is with the merchant ships; on board of every ship there will be Officers (amongst them the doctor), willing to undertake the task, and able to make even the more difficult observations *e.g.*, the hydrometrical and psychrometrical.

VI.—*Discussion.*

Those occupied with the discussions of the observations will find suggestions for the best mode in the respective works of others, and occasionally modify the plan according to abilities and the end in view. It seems difficult to imagine general rules for such work.

VII.—*Subjects of Inquiry.*

The division of labour does exist, in fact, to a certain extent. The Maritime Department of the Meteorological Office in London, the Institutions of Utrecht, Christiania, and Hamburg have each their respective field of investigation. But the distribution of scientific material collected, is not yet organized, and that should be the case, because else a great part of the observations is wasted, not coming into the right hands. This could be attained if every Institution (or scientific man) would let the Sub-Committee know which part of the ocean it (or he) is working out, and what kind of data are wanted. Then the Sub-Committee could organize a fair interchange of observations, addressing itself to all those Central Institutions which supply ships with journals and instruments.

VIII.—*Sailing Directions.*

I consider it the greatest benefit to the interest of science as well as to the material welfare of the nations, if practical investigations, such as preparation of Sailing Directions, are carried out by Scientific Institutions, although that ought never to be considered their direct duty.

Commodore R.H. Wyman, Hydrographer, U.S.N., Washington.

I.—*Observations.*

Replying to the questions under the head of Observations, I would state:—
Cols. 1 to 6. That in the construction of the Meteorological Journal (by Lieutenant-Commander George W. Sumner, U.S.N.), lately issued by this

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Office, a copy of which has been forwarded to you, it was not considered necessary to introduce the columns of Course and Distance by Log for every four hours, but observers have been requested to record the ship's position not less than three times daily, and the hours of 4 a.m., Noon, and 8 p.m., are specified as those most desirable for these records, more frequent records being made on all special occasions, such as the approach to or departure from a Trade Wind, Stream, Current, or Calm Belt.

Col. 9. It was deemed sufficient to request that the Variation as recorded should be divested of the local deviation.

Cols. 10 & 11. It would seem possible, and certainly is desirable, to introduce some mechanical means for measuring the force of the wind at sea, that the results may be reliable and comparable with each other as also with those of observations on shore. Should the Beaufort scale be universally used, without the means of measuring mechanically the force of the wind, the results would be far from comparable; generally the estimate will be much higher in small than in large vessels, and different individuals on board the same vessel will frequently estimate the force of the wind widely apart.

Cols. 12 & 13. The barometer should be recorded to hundredths of an inch.

Cols. 14 & 15. The record of the thermometer attached to the barometer and the temperature of the air and water should be required from all ships making these observations, the wet-bulb only from national vessels.

Col. 16. It would seem desirable that the form and direction of both the upper and lower stratum of clouds be noted.

Col. 17. It would hardly seem material whether the column were headed "Proportion of Sky Clear" or "Proportion of Sky Clouded," as long as it is distinctly understood what is the signification of 0 and what the signification of 10 in the column noting the proportion of sky clear or clouded.

Col. 18. It seems desirable that the state of the weather should be recorded, first in considerable detail, even to the hours of continuance of any particular incident of the weather, and secondly, the general state of the weather by symbols, this latter being solely a confirmation of the accuracy of the former.

Col. 19. As a numerical scale is used for the wind force, and a second for recording the proportion of clear sky, it is thought desirable to record the state of the sea by means of a set of symbols, the letters used for which in the Journal offered by this Office, are in a measure suggestive of the state of the sea which they are intended to represent.

Cols. 20–22. It is considered desirable, for the facility of reference and calculation, to provide columns for the notation of all surface observations and for the occasional observations for temperature and specific gravity at depths; any observations on either, of a serial nature, must necessarily come under the head of Remarks.

II.—*Instruments.*

The objection to the adoption of the Metric and Centigrade systems is, that the present considerable supply of instruments are graduated on the English system, and the large amount of data on hand has been recorded in accordance with that system; the facility with which one system is converted to the other, can make little difference in the labour of collation.

Uniformity is desirable in the deep-sea sounding apparatus and in the method of sounding. For deep sea temperatures the "Miller-Casella" thermometer is used by our naval vessels; for the purpose of obtaining the specific gravities, the hydrometer recommended in the instructions in the original Abstract Log is used.

III.—*Instructions.*

It would seem possible, and is certainly desirable, that a general form of Instructions to secure uniformity in regard of methods of observation and registration, be devised.

IV.—*Observers.*

It would appear to be desirable that all the meteorological instruments to be used in making observations for record in the journals should be the property of the Central Establishment employing the Observer, not only from the

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increased number of Observers thus obtained, but because in no other manner can records, having a fair degree of reliability, be secured.

V.—*Co-operation of the Royal Navy.*

All Naval vessels of the United States are required by the Navy Department to fill up and return the Meteorological Journals issued from this Office.

VI. and VII.—*Discussion and Subjects of Inquiry.*

The United States Hydrographic Office (in its Meteorological Department) under the Bureau of Navigation, will be always ready to consider any general suggestions as to the most profitable mode of discussion of observations, but while it regards with much interest the proceedings of the various Meteorological Conferences, and the growing popularity and importance of the science of Meteorology, it is not prepared to enter into any arrangement for a division of labour as regards Subjects of Inquiry.

The Journal issued is for the collection of data for a specific purpose, the revision of our present Wind and Current Charts, this being the only subject of inquiry in this science in which it is at present engaged. To the end that our Journals may be of the highest order required for the collection of meteorological data for this purpose, we are ready to receive any suggestions which may be made.

VIII.—*Sailing Directions.*

The preparation of general Sailing Directions describing the winds, currents, and phenomena of the Ocean would appear to be a subject, admissible for a Scientific Institute. Sailing Directions for coasts and harbours, can only be prepared by Hydrographic Surveyors and Experts.

Appendix D.

Proposed English Instructions for keeping the Meteorological Log.

Pages of Meteorological Log.

It may be well to commence these Instructions with the all-important remark that regular *honest* observations, in *fine* as well as bad weather, are what Meteorologists require, and that a blank space is very much preferred to a doubtful entry, because one bad observation vitiates many good ones.

To make the Instructions as clear as possible they commence with the introductory pages of the Meteorological Log in the order of their numbers,* and then deal in the same way with the columns of the Form of Log, which columns are numbered from left to right at the bottom of each page. It will be seen that the columns of the Rough Book bear the numbers of those in the Meteorological Log which contain the same observations.

1. Names of Ship, Captain, and Keeper of log. Corrections for Instruments.

The upper part of this page needs no explanation.

All instruments belonging to the Meteorological Office are compared with standards before they are issued, so that this form should be left blank, except in cases where other instruments than those of the Office are in use; these should be compared with instruments issued by the Office, or other Standards when opportunity offers.

When a ship has private instruments as well as those belonging to this Office it is very important that they should be recorded at the same time as those belonging to the Office for several days at the commencement of the voyage, so that if the Office instruments get broken the ship's may be taken into use, and a fair error found for them. *The comparisons should extend over as great a change of pressure and temperature as possible,* so as to test the different parts of the scales. As we only supply one barometer, it is much more important that it should be compared with the ship's than in the case of thermometers, &c. The readings of both barometers should be given in the Log during different parts of the voyage, and in fine, as well as stormy, weather.

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*With this Appendix it has only been considered requisite to give pages 15 and 16, which are a printed specimen of the log proposed, but much reduced in size. See the end of this Appendix.

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Beaufort's Notations of Wind and Weather explain themselves; they are alluded to again on pages 50 and 56 of these Instructions, when speaking of columns 11, 12, and 20 of the Log. It may be well to remind the Navigator that the speed of Beaufort's ship is what she would make in a *smooth* sea; therefore, to estimate the force of a wind, he must consider what speed a well-conditioned man-of-war of Admiral Beaufort's time (1800 to 1850) would be driven by it in a smooth sea when "on a wind." Pages of the Meteorological Log. 2. Wind and Weather notations. Sea Disturbance.

The best authorities have decided that with force 5 Beaufort's ship would have sailed 9 knots an hour when "on a wind," "full and by," in a *smooth* sea. To assist the Navigator the following comparison is given of Beaufort's scale of wind force up to 5, with the speed of his ship.

Beaufort's scale of wind force	1	1·5	2	2·3	2·8	3	3·3	3·8	4	4·1	4·4	4·7	5
Miles per hour which Beaufort's ship would sail when "clean full" in smooth water	½	1	1½	2	3	3½	4	5	5½	6	7	8	9

Since Admiral Beaufort's time there has been a great change in the rig of merchant ships by the introduction of double topsail yards; it has therefore been thought advisable to add to Beaufort's scale the amount of sail which his ship would have been able to carry, had she been rigged with double topsail yards, but all other circumstances the same. The change would only affect Beaufort's wind forces 6, 7, 8, 9, and 10.

The equivalents are:—

Force 6.* Top gallant sails.
„ 7. Topsails, jib, &c.
„ 8. Reefed upper topsails and courses.
„ 9. Lower topsails and courses.
„ 10. Lower main topsail and reefed foresail.

The figures indicating the *Disturbance of the Sea* are those in use at our telegraph stations, and save a certain amount of writing.

Barometer and Thermometer Range.

The inches and tenths of the barometer and degrees of the thermometer are given on the upper part of the page. Each vertical line represents a tenth of an inch of the Barometer, and 2° Fahr. of the thermometer; the eye easily divides the space between the lines into hundredths of an inch of the barometer, and into single degrees, halves, or even quarters of a degree of the thermometer. 3 to 6 Diagrams.

The horizontal lines represent four-hourly periods of time.

These Diagrams are filled in by making dots on each time line to represent the readings of the barometer and thermometer at that time; these dots are joined by lines of different thicknesses or colours; or, if preferred, by plain and dotted lines. Instrumental records for each hour can be recorded, if necessary, as the eye easily divides the four-hourly space into quarters.

It is better to record on the Diagram the open air thermometer instead of that attached to the barometer. Some observers also add the sea temperature, direction, and force of wind, weather, sea, clouds, &c.; they make a very interesting picture of what has been, and in some cases help the Navigator to judge of what is coming.

The Diagrams are not required for use in the Meteorological Office, and are chiefly intended to help the Navigator. Very interesting facts have, however, been learnt from them, as will be seen in the Non-Official Report, No. 2, published by the Meteorological Office, in which it is shown that the barometer is much more disturbed on board a steamer going from England to America than during her return passage. Also that the barometer frequently rises during a southerly wind on board a steamer coming to the eastward, from America, but seldom or never during a southerly wind on board one steaming fast to the westward.

* Here it may be well to remark that the reason why a ship having double topsails can carry them unreefed longer than she could the old single ones, is because the pressure of the whole of single topsails is on the top-mast head and rigging, whilst in the case of double topsails, the topmast head and rigging only get the pressure of half or at most two-thirds of the whole sail.

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Pages of the Meteorological Log.

Those Observers who have but little spare time should devote it to recording honest and good observations, as it is *their* quality, and not the neatness of the Diagrams which decides the value and character of a Log.

7 to 14. Deviation of Compass.

These pages are devoted to various methods for finding and recording the Deviation of the Compass, they need no explanation. The use of iron in the construction of ships has rendered the question of compass errors so important and so complicated that it cannot be dealt with here. The following works on the subject will be found useful:—

Admiralty Manual for the Deviations of the Compass.

Elementary Manual for the Deviations of the Compass in Iron Ships. By Capt. EVANS, C.B., F.R.S., Hydrographer to the Admiralty. Published by J. D. Potter, 31, Poultry, London.

Practical Information on the Deviation of the Compass, by J. T. TOWSON, F.R.G.S. Printed for the Board of Trade by H.M. Stationery Office.

Magnetism and Deviation of the Compass, by J. MERRIFIELD, LL.D., F.R.G.S.. Published by Longmans & Co., Paternoster Row, London.

Sun's True Bearing, or Azimuth Tables, by Capt. J. BURDWOOD, R.N. Printed for the Admiralty by H.M. Stationery Office.

To those who wish to go more deeply into the subject the following work will be found useful:—

A Treatise on Magnetism by Sir. G. B. AIRY, K.C.B. Published by Macmillan & Co., London.

The Navigator must remember that for the purposes of Meteorology the *true* direction of the wind, clouds, &c. is required, so that if it is not recorded at once in the Log (which is the best plan), he must give the total compass error, or the data for finding it, for every change of course, so that the true direction of each observation can be deduced.

15 and 16. Specimen sheet of Log.

(*See the reduced printed specimen at the end of this Appendix.*) These pages contain a form of Log showing four days correctly filled up; it is given to guide new Observers. The heading of each column in the specimen is more full than that in the rest of the Log, the same has been done in the case of the Rough Book; the intention is to make as clear as possible to the new Observer, what it is we wish to have recorded in each column.

Form of Log.—The columns are numbered at the bottom from left to right, and will be remarked upon in the order of their numbers. The columns numbered 1, 2, and 7 to 25 will also be found in the Rough Book, so that the remarks on them will refer to either book. The Navigator is advised to take the space of the first day in each log for remarks on the correction to be applied to the direction of the wind, cloud, sea, &c. &c., the position of the barometer and thermometers, &c. &c. See the specimen columns of the Meteorological Log at the end of this Appendix.

Columns of the Meteorological Log.

1 and 2. Date.

Date.—The name of the month may be written, or its number given in Roman letters, as shown in specimen Log, where VI. means June.

Civil time is required, the same as that used on shore, where the day commences at midnight. The day of the month should be entered to the left of 2 a.m. in the Log and 4 a.m. in the Rough Book. The Log Book is ruled for two-hourly periods, and it is hoped that the direction and force of the wind will be given every two hours, but on all ordinary voyages it is sufficient to give other data for four-hourly periods, except during hurricanes or other exceptional weather, when the space of two or more days may be taken for one if required.*

For distinction the figures showing every fourth hour in the Log are in larger type than the others. The Rough Books are only ruled for four-hourly observations so as to keep them handy, but lines are given for the two-hourly winds. If the observer finds that he can observe *thoroughly good* observations every two hours, then he must take two days of the Rough Book for one day's observations, and alter the hours accordingly.

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* It is very desirable that observations should be entered for all the four-hourly periods, since the *constant* omission of any one such period renders it impossible to utilize the others for diurnal range and similar work, though an *occasional* omission is of little importance.

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When observations are only taken each four hours, copying from the Rough Book into the Log will be made easier, if the four days from one opening of the Rough Book be copied into one opening of the Log. Columns of the Meteorological Log.

Latitude and Longitude.—The ship's positions by both Observation and Dead Reckoning are required at Noon when possible, and oftener when convenient. Their difference is required for calculating the "Current in last 24 hours," which is recorded on the Noon line of the Remark Column, No. 25. It is hoped that the Captain will himself calculate the Current each day, as nobody can decide so well as he whether the positions are sufficiently trustworthy; if they are not trustworthy, the fact should be recorded in the space where the current would otherwise be entered. If he can get it more frequently than each 24 hours, it should be recorded in the Remarks. 3, 4, 5, and 6. Position.

True Course and Distance by Log each Four Hours.—As the latitude and longitude of each observation is required, the course and distance between each set of Meteorological observations will give much more correct results than can be arrived at by interpolating between the noon positions, for they will show the effects of changes of wind, tacking, &c. The true course and distance each four hours are also very useful data for the Navigator when near land, and it is a good practice to have them always carefully worked out. They are not, however, considered to be absolutely necessary to constitute an "Excellent Log." 7 and 8. Course and Distance.

Total Compass Error.—This column contains the Variation and Deviation combined. The compass error required is that of the compass by which the directions of wind, clouds, &c., are recorded. Without it the *true* direction of wind cannot be discovered, and the wind observations of ships in which the compasses have much deviation are rendered comparatively useless. Some Captains record the *true* direction of the wind, which is preferred. It must, however, be remembered that to get the true direction of wind, &c. from an uncorrected compass reading, this Office requires the total compass error or variation and deviation for each change in the direction of the ship's head. 9. Total Compass error.

Whatever plan is followed, it should be clearly stated in the Log at the commencement of each voyage. A good letter on the compasses of iron ships, by Mr. W. W. Rundell, is given on the second page of the Rough Book. For further remarks on the deviation of the compass, see p. 48 of these Instructions, where pp. 7 to 14 of the Log are alluded to; these pages contain various forms for recording the deviation, and the best works on the subject are mentioned.

Ship's Head by the same Compass as the Wind.—Also Degrees of Heel to Port or Starboard (*P. or S.*).—The direction of the ship's head is especially needed with each record of the wind in those ships which do not give its *true* direction. Without it the requisite deviation cannot be taken from the Table of Deviations which all ships are supposed to have recorded on pages 7 to 14, and which, combined with the variation, gives the compass error. The direction of ship's head is also useful in cases where a Deviation Table is not filled up, for with it, together with the compass error and variation, an approximate Deviation Table can be constructed. Of course it is known that a ship's deviation often changes with her geographical position, so that it should be observed as frequently as possible. The amount of heel is required, as it frequently affects the amount of deviation, and its influence should be known. These facts are well explained in the works alluded to on page 48. 10. Ship's head and degrees of heel.

Direction of Wind.—The direction of the wind should be given to the nearest point, and, if possible, every two hours. It should be clearly stated at the commencement of the Log whether this direction is true or subject to total compass error, or only to variation. The course and speed of the ship make the *apparent* direction of the wind by a vane differ from the *true*, especially in fast steamers; but experienced seamen can generally estimate it by the direction from which the tops of the waves or the *lowest* clouds come. This observation is asked for *at the time of observing*, and not an estimate of the direction since the last observation. If a squall is blowing at the time of observing, the direction and force which existed before the squall should be entered in the Direction and Force columns, and the direction, force, and duration of the squall should be entered in the Remark Column (No. 25), with any other important remark respecting it, such as how the wind changed during the squall, &c. &c. It is particularly requested that the direction, force, and duration of squalls be entered in the Remarks, and if they are too numerous, then their general character. It is also most important that the exact time of any important change in direction 11. Direction of wind.

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Columns of the Meteorological Log.
12. Force of wind.

or force of wind should be recorded in the Remarks; this becomes more and more important now that it is frequently found requisite to draw daily charts of the wind, weather, &c., over certain parts of the sea, for by means of such observations the track and rate of motion of certain changes can be made out.

Force of Wind.—The force of the wind is estimated by Beaufort's scale, see page 2 of the Log and its explanation on page 47 of these Instructions. It ranges from 0, a calm, to 12, a hurricane. Between 0 and 5 it depends upon the speed at which a well-conditioned man-of-war of Admiral Beaufort's time (1800 to 1850) could "sail on a wind," "clean full," in a smooth sea. From 5 to 9 it depends on the amount of sail which the same ship could carry when on a wind "full and by." From 10 to 12 also it depends upon the amount of sail that the same ship could carry, but she is not necessarily "on a wind," though in the case of 11 she would be so.

To use this scale correctly the Navigator must not use the speed or sail of his *own* ship as the criterion, unless he supposes that she fairly represents a well-conditioned man-of-war of Admiral Beaufort's time, but he must endeavour to estimate what Beaufort's ship would do with the existing wind, and in the first four, or, we may say, five cases, he may suppose that the sea is smooth. It has been decided by the best authorities that Beaufort's ship would have sailed 9 knots with force 5 in a *smooth* sea.

See page 47 of these Instructions for the comparison of Beaufort's scale with the speed of his ship, where it is given in the explanation of page 2 of the Log. Beaufort's scale of wind force is also given on the first page of the Rough Book, so that the Observer has it handy for reference.

13 and 14. Barometer and attached thermometer.

Barometer and its attached Thermometer.—Next to the direction and force of wind, the readings of the barometer are most important. Unfortunately they have not been always carefully taken in fine weather, though to the Meteorologist they are just as important then as when the weather is unsettled.

The number of the instrument and the height of its cistern (or lower end) above the sea level must be entered in the upper part of the column, and any change in its position or height of the cistern should be recorded in the Remarks; of course, the height of the cistern is affected by a change in the ship's draft of water. Captains are also requested to state in the column for Remarks whether their barometers "pump" much, *i.e.*, whether the quicksilver rises or falls when the ship has much motion, so as to prevent their getting a correct reading, and to state how much they do pump. Of course in such cases the reading entered in the Register should be the mean between the highest and lowest points of the oscillation. The attached thermometer must always be recorded at the same time as the barometer. This observation is especially valuable if the instrument is influenced by heat from a lamp, a fire, or the sun.

The following directions for handling the barometer should be carefully studied by a new Observer:—

Barometer.

In handling barometers it should always be remembered that they are delicate and expensive instruments. The result of rough treatment is breakage, and for scientific purposes, observations from an instrument improperly repaired and not verified are useless.

The barometer should be fixed in a good light for observing, but out of the reach of sunshine or the occasional heat of a fire or lamp. The ill effects of artificial heat are, however, nearly completely obviated by taking a careful reading of the attached thermometer at the time of observation of the barometer. It should hang where it can swing freely, and be out of the reach of passengers or others passing near it, so as to be carefully protected from injury. The height of the cistern or lower part of the barometer above the level of the sea should be ascertained and noted in the Log at the beginning of each passage.

Fixing up.

A bracket and screws for suspending the barometer are in its box. Screw up the bracket where the barometer is to hang. Then lift the instrument carefully out of its box, bend back the hinged part of the suspension arm, and slip it into the bracket. (The holding screws should not be driven quite home until the instrument is in position.) The mercury will then fall gradually, and the instrument will usually be ready for observation in about an hour; but as local temperature affects the instrument slowly, it may be well not to record observations from it for some hours after first fixing it. In a well-boiled tube, the mercury hangs adhesively sometimes, and will not quit the top of the tube. If, after an hour or so, the mercury has not descended to its proper level, tap the cistern end rather sharply with the hand, or make the instrument swing

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a little in its gimbals. This difficulty very rarely happens, and no precise mode of treatment can be laid down: the remedy lies much at the judgment of the Observer, who should use such means as his discretion may lead him to deem best to cause the mercury to fall. The box should be safely stowed away.

Taking it down.

Whenever it may be necessary to take down a barometer and stow it in its box, *the vernier should be brought down to the bottom of the scale.* Then, having lifted the instrument out of the bracket, place or hold it in an *inclined* position for a few minutes, so as to allow the mercury to flow *very gently* up to the top of the glass tube. It should then be taken lengthwise and laid in its box. It is now portable, without any other adjustment whatever; and may be carried with the *cistern end upwards* or *lying flat*, but it must not be subjected to jars or concussions.

Packing it.

Experience shows that it is advisable to give some directions as to packing barometers. The instrument having been taken down and placed in its box as directed, if it is to be sent by rail or other conveyance, and will probably have to be handled by persons unacquainted with its delicate and peculiar construction, should be placed in a packing case with two or three inches of soft elastic packing all round it, as hay, straw, shavings, tow, or paper-cuttings. The lid of the case should *never be nailed down*, but always fastened with screws, The address label should be *pasted* (not nailed) on the end of the case which is next the cistern, or lower end of the barometer, and it should be marked "Glass and fragile instruments. Keep this box lying flat, or carry it this end upwards." Of course, if two or more barometers are packed together, the cisterns should all be placed at this marked end of the case. Barometers should be transmitted by passenger train, and, in short, always by whatever route or conveyance affords the most safe transit. Transhipment or change of conveyance should be avoided if possible.

Barometer Vernier.

Principle of the vernier.

In order to facilitate the taking of accurate readings of the height of the barometer, a small moveable scale, called a vernier, is attached to the instrument.

The general principle of this moveable dividing scale is that the total number of the smallest spaces or sub-divisions of the vernier are made equal, taken together, to one less or more than that number of the smallest spaces in an equal length of the fixed scale. In standard barometers the twenty-five spaces in the vernier are equal to any twenty-four spaces of the scale, which are each half a tenth or five hundredths of an inch; therefore a space on the scale is larger than a space on the vernier by the twenty-fifth part of ·05, which is ·002 inch, consequently the vernier exhibits differences of ·002 of an inch.

Setting the vernier.

The vernier is moved by a rack and pinion. Turn the milled-head of the pinion so as to bring the *lower* edge of the vernier exactly on a level with the top of the mercurial column. When set properly, the front edge of the vernier, the top of the mercury, and the back edge of the vernier should be in the line of sight, which line will thus just touch the *middle* and *uppermost* point of the column. Great care should be taken to acquire the habit of reading with the eye exactly on a level with the top of the mercury, that is with the line of sight at right angles to the scale.

A piece of white paper placed behind the tube, so as to reflect the light, assists in setting the vernier accurately. A small bull's-eye lamp held behind the instrument enables the observer to get a correct setting at night. When observing the barometer, it should hang *freely*, not being inclined by holding, or even by a touch; because any inclination will cause the mercury to rise in the tube.

Every long line { cut on the barometer scale corresponds to }	a tenth	(·100)	of an inch.
„ short „ „ „	five hundredths	(·050)	„
Every long line { cut on the vernier scale corresponds to }	one hundredth	(·010)	„
„ short „ „ „	two thousandths	(·002)	„

Reading the barometer.

The mode of reading off may be learned from a study of the following Diagrams, in which A B represents part of the scale, and C D the vernier, the lower edge D denoting the top of the mercurial column. The scale is readily understood; B is 29·000 inches; the first line above B is 29·050; the second line 29·100, and so on. The first thing is to note the scale line just below D, and the next is to find out the line of the vernier which is in one and the same

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Columns of the Meteorological Log.

direction with a line of the scale. In figure (1), the lower edge of the vernier, D, is represented in exact coincidence with scale line 29·5; the barometer therefore reads 29·500 inches. Studying it attentively in this position it will be perceived that the vernier line *a* is ·002 inch below the next line of the scale. If, therefore, the vernier be moved so as to place *a* in a line with *z*, the edge D would read 29·502. In like manner it is seen that *b* is ·004 inch away from the line next above it *on the scale*; *c*, ·006 inch from that next above it; *d*, ·008 inch from that next above it; and 1, on the vernier, is ·010 below *y*. Hence, if 1 be moved into line with *y*, D will read 29·510. Thus the numbers 1, 2, 3, 4, 5, on the vernier, indicate hundredths, and the intermediate lines the even thousandths of an inch. Referring now to figure (2) the scale line just

Fig. 1.

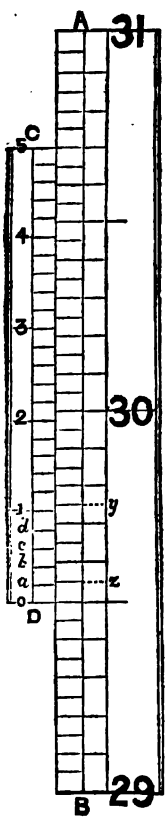
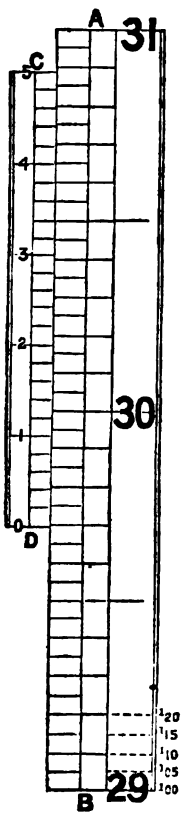


Fig. 2.



below D is 29·650. Looking carefully up the vernier, the third line above the figure 3 is seen to lie evenly with a line on the scale. The number 3 indicates ·030, and the third subdivision ·006; and thus we get—

Reading on scale - - -		29·650
Reading on vernier - - -	·030	
	·006	
Actual reading - - -		29·686 inches.

Sometimes two pairs of lines will appear to be coincident; in which case the intermediate thousandth of an inch should be set down as the reading. Thus, suppose the reading appears to be 29·684 or 29·686, the mean 29·685 should be adopted.

Thermometers.—The numbers of the Instruments in use should be entered at the heads of the columns, and every change during the voyage should be

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recorded in the Remarks. At the commencement of the voyage the position of the screen containing the thermometers should be plainly stated, and any changes recorded. The thermometers should be read to tenths of a degree, which are easily estimated by the eye. Readings below zero should be preceded by the minus sign thus,—15°, the minus sign must be repeated with each observation that is below zero. Columns of the Meteorological Log.

The following Instructions should be carefully studied:—

Dry and Damp Bulb Thermometers.

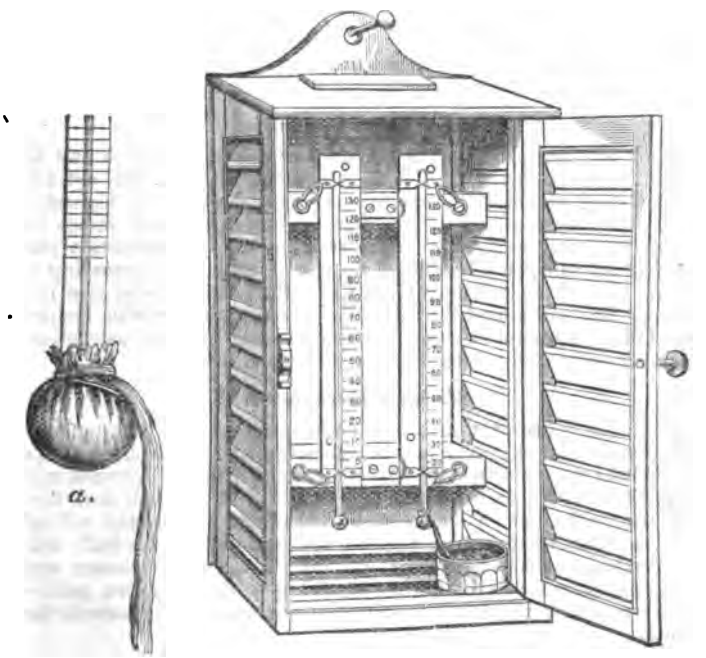
It is not at all an easy matter to obtain a record of temperature which shall be altogether unexceptionable. If an open exposure is available, a louvre-boarded case, or screen should be set up to contain the thermometers. There is a great difference of opinion among Meteorologists as to the best form and size for such a screen. It would be suitable for its purpose if it afforded perfect shelter from the sun's rays falling directly upon the instruments and allowed free circulation of the air about them, keeping them at least three or four inches from the sides and front of the screen itself. Thermometer screen.

The annexed engraving shows the form of screen used for mounting the dry bulb and wet bulb thermometers on board ship, where it should be fixed in any available position on the upper deck, so as to be freely exposed to the external air, but protected from sun, rain, or spray, and about four feet from the deck.

Two thermometers should be fitted up in the vertical position in the screen, one to give the temperature of the air, and the other that of evaporation. They should be without cases or guards, near each other, but not within a less distance than two or three inches, and as free as possible from radiation from cabins and engine rooms, and from draughts near windows of warm rooms.

One thickness of the finest muslin or cambric should be tied round the bulb of one thermometer, and a few threads of cotton wick passed round the

Fig. 3.



glass stem close to the bulb* (see *a*, fig. 3), touching the muslin, and long enough to reach two or three inches below the lowest part of the bulb, should

*8 or 10 threads formed into a loop or "bight" in their middle, having their ends passed round, above the bulb, and through the bight.

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Columns of the Meteorological Log.

be carried down so as to dip into and remain in a small vessel of water. By this arrangement the water is slowly conducted, by capillary attraction, to the bulb and evaporated there. See fig. 3.

The cup, glass, or other small holder of water ought not to be under or too near the dry thermometer. This little reservoir should be on the off side of the wet thermometer, that is, as far as possible from the dry thermometer, which of course should not receive any moisture either from rain, spray, or otherwise. The water should be either distilled or rain water, or, if this be not procurable, the softest pure water which can be had, to avoid the inconvenience of the deposit of lime, &c. on the bulb. The water vessel should be replenished *after*, or some little time *before* observing; because observations are incorrect if made while the temperature of the water differs from that of the air.

The muslin and wick should be well washed before being applied, and occasionally while in use. They should be changed once or twice a month or even oftener, according to the quality of the muslin, &c., and the exposure to *dust* or *blacks*. Accuracy depends much on the care taken for cleanliness, and for a proper supply of fresh water. The temperature of evaporation is a very important observation, and therefore especial care should be taken to make it correctly.

In our climate the usual difference between the readings of the dry and wet bulb thermometers ranges from 0 to 12 degrees in *outer* air on land, but at sea the difference seldom exceeds 6 or 8 degrees.

When the wet bulb is frozen it should be wetted by means of a camel-hair brush or feather with some cold water taken from under ice, care being taken to raise its temperature as little as possible. After waiting a few minutes, the moisture will first freeze, then cool down to the temperature of the air, and finally the thermometer will fall a trifle lower than the dry one, and then the temperature of evaporation may be noted. It is only when there is absolutely no water, either fluid or frozen, upon the bulb, that it fails in cold weather; and allowing for the error of the instrument, it can only read higher than the dry bulb when the water is warmer than the air, which it never should be for the purpose of a correct observation.

Maximum and Minimum Thermometers are not generally supplied to ships, but the following Directions may be useful for special cases.

Maximum Thermometer.

Suspend the instrument in a horizontal position, the bulb end slightly depressed. On an increase of temperature the mercury will extend itself along the stem and remain with its extremity showing the highest degree reached. On a decrease of temperature the mercury cannot recede into the bulb until it is reset for a future observation, owing to a restriction placed in the bend of the tube, or a bubble of air placed in the stem, according to construction. To set the instrument hold it bulb *downward*, and give it one or two jerks. This will adjust the column of mercury to the existing temperature, and the Observer should be careful to assure himself that the instrument when set reads correctly with an ordinary thermometer.

Minimum Thermometer.

Suspend the instrument in a horizontal position, the bulb end slightly depressed and below the maximum thermometer in the same screen. To set the index, hold the thermometer bulb uppermost until the index descends to the end of the spirit. With a decrease of temperature the alcohol will draw the index towards the bulb; but on an increase of temperature the fluid will advance beyond the index, leaving it so that the end remote from the bulb will show whatever extreme of cold may have occurred. If the spirit becomes separated hold the thermometer bulb downward, and give it one or two good swings with the arm. This will cause the detached portions to flow towards the bulb and unite.

Owing to the volatility of alcohol with which spirit this thermometer is made, a little will in course of time be carried away from the column and condensed at the sealed end of the tube. Hence it is necessary to compare a spirit thermometer from time to time with a mercurial thermometer of known accuracy. Should they not read alike, the upper end of the spirit thermometer

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should be examined closely, and if any spirit be apparent there, it should be shaken down. Columns of the Meteorological Log.

When observing, neither the maximum nor the minimum thermometer should be touched by hand until the readings of the indices have been recorded.

Clouds.—The following plates and explanation of clouds are repeated at the end of the Rough Book for easy reference by the Observer when recording them. Each cloud entry should be what exists at the time of observing. 17, 18, and 19, Clouds.

Explanation of the Forms of Clouds.

The following explanation of the different forms represented on the Plate has been prepared principally from the works of Luke Howard.

Upper Clouds.

Fig. 1. Cirrus. (Cir.) This is the very lofty cloud which looks like hair, thread, or feathers, and is often called "Mare's tails." It frequently moves in a direction different to that of the wind at the earth's surface.

Fig. 2. Cirro-cumulus. (Cir.-c.*) This is also a high cloud; it differs from the *cirrus* in being more globular in form, as it consists generally of small detached rounded masses, like a flock of sheep lying down, or like the markings on a mackerel, whence the name "Mackerel sky." They are sometimes seen at lower levels, when it may be difficult to distinguish them from small *cumuli*. (See the remark about cir.-s.)

Fig. 3. Cirro-stratus. (Cir.-s.) This resembles the *stratus* in being a sheet or layer of uniform thickness, but it belongs to the higher regions of the atmosphere.

Whenever there is a doubt the Observer had best enter the cloud either as "high str." or "low cir.-s." It often happens that the Observer looks upon the edge of a layer of *stratus* or *cirro-stratus*, which appears like a straight line, as in the case of the horizontal bands across the *cumulo-stratus*.

The distinction between *stratus* and *cirro-stratus* seems to depend on the relative levels above the earth's surface, at which they are observed. Clouds are seen at all levels between the highest *cirrus* and the lowest *stratus*, so that it is often difficult to determine whether a particular sheet or layer of cloud is a high *stratus* or a low *cirro-stratus*.

The same remark is applicable to *cir.-c.* and the smaller forms of *cumulus*, for there is a stage in which they seem, as it were, to run into each other.

Lower Clouds.

Fig. 4. Stratus. (Str.) This is a sheet or layer of cloud, of uniform thickness. It has but little variety of light and shade, and belongs to the lower regions of the atmosphere, so much so that Luke Howard speaks of it as "Ground Fog," the cloudy formation which spreads over low grounds in the evening. All low detached clouds, which look like a piece of lifted fog, and are not in any way consolidated into a definite form, are *strati*, and may be called "detached" *stratus*. When a *stratus* is at a high level, it may pass into a *cirro-stratus*, which see.

Figs. 5 and 6. Cumulus. (Cum.) This class of clouds comprises all those which have a globular or rounded form, from the small white cloud represented in Fig. 5, to the heavy mass represented in Fig. 6, which is almost a *cumulo-stratus*. The *cumulus* sometimes takes a cylindrical shape, forming itself into long horizontal rolls, between which gleams of light are seen, but which are often so closely packed as to hide the blue sky. These are called by us *Roll-cumulus* (*Roll-c.*)† See Fig. 5.

Fig. 7. Cumulo-stratus. (Cum.-s.) This is the *cumulus* as it were changing into a *nimbus*. It is dark and flat at its base, and is traversed by horizontal lines of dark cloud.

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* NOTE.—The second part of the contraction has been reduced to one letter, because it is found that in practice the hyphen has frequently been left out, so that cir.-cum. was understood as *cirrus* and *cumulus* instead of *cirro-cumulus*. This error has been common to all the contractions.

† This variety of *cumulus* is an addition to Howard's nomenclature.

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Columns of the Meteorological Log.

Fig. 8. Nimbus. (Nim.) This is a Rain-cloud. Whilst on the horizon, or as it advances towards the Observer, its front frequently presents a marked outline like that of a very heavy *cumulo-stratus* with rain falling from it, and with some *cirrus* above, so that Howard has called it the *cumulo-cirro-stratus*. When it has overspread the whole sky, it is usually so mixed up or concealed by the falling rain, that it generally assumes an uniform dark appearance.

Fig. 8, represents a *Nimbus* before it has overspread the sky; there are also smaller clouds of the same kind which only produce a passing shower. They are easily distinguished by the fact that rain or snow, &c., is falling from them.

It is believed that the foregoing description is sufficient to explain the ordinary forms of clouds, but the appearances are much intermixed. Thus, before rain we often see a dirty background of *cirro-stratus*, over which black patches of *cirro-cumulus* are travelling. Such combinations may be noted in the column for "Remarks."

17. Lower clouds.

Column 17 is devoted to the *names of the lower clouds*. The direction from which they come is not needed, unless it differs much from that of the wind, in which case a special entry should be made in the remark Column, No. 25.

18. Upper Clouds.

Column 18 is for the *names of upper clouds, and the direction from which they are passing over the sun, moon, or stars.* The direction from which *upper* clouds move should be recorded whether they are moving with the wind or not, and it is an observation which is much prized. The relative motion of clouds past other clouds, or any moveable object, is so deceptive that it should never be recorded. If the upper clouds move very quickly a remark should be made to that effect. It is particularly requested that the contractions Cir., Cir-c., Cir-s., Str., Cum., Cum-s., Roll-c., and Nim., which are given on the plates, be used in columns 17 and 18, as any other contractions are liable to mislead.

19. Amount of cloud.

Column 19. *Proportion of sky clouded*, or Amount of Cloud. It is represented by figures, 0 meaning "No clouds," and 10 "Completely clouded."

20. Weather.

Weather is recorded according to Beaufort's Notation, which is given on p. 2 of the Log, and p. 1 of the Rough Book.

The weather reported should be that which exists at the time of observation, and not an estimate of what has been since the last observation; except in the case of fog, rain, snow, or hail, when their initial letters should be preceded by a figure showing the number of hours that they have lasted during the time elapsed since the previous observation.

Any important facts respecting the weather, which cannot be shown in Col. 20 should appear in the Remark Column No. 25, such as the kind of lightning, with the direction in which it is seen, or thunder heard; and especially the direction, duration, and force of squalls, with the veering of the wind in them. When squalls are numerous, their general character should be explained in the Remarks.

A dash under a letter means increased intensity, thus :—

r	means	heavy rain.
w	,,	very heavy dew.
q	,,	an extremely heavy squall.

As some observers have been led into the mistake of using

d	instead of	w	for	dew;
h	,,	m	,,	haze or mist;
s	,,	p	,,	showers, and
s	,,	q	,,	squalls,

it seems well to remark that when the first letter of a word has already been appropriated, another has been taken. In the case of showers "p" alludes to the word passing, as showers are supposed to be passing.

21. Sea or swell direction.

Direction from which sea or swell comes.—This should be given by the same compass as the direction of the wind. If, besides the sea produced by the existing wind, there are swells from other quarters, they should also be given in this Column, stating that they are swells. In cases where the Column will not contain the important facts relating to the sea, they should be entered in

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the Remark Column, No. 25. Although the direction of the sea is usually only given in general terms, such as westerly, south-westerly, &c., it is important to know whether or not the compass error has to be applied, as in some parts it amounts to several points. Columns of the Meteorological Log.

Disturbance of Sea.—This is expressed by figures 0 to 9, and is explained on page 2 of the Log and 1 of the Rough Book, where it follows the Beaufort Notation. The same scale is in use at the land telegraph stations along our coasts. 22. Sea disturbance.

Surface Temperature of the Sea.—The thermometer used for surface temperature should be protected by a metal case having a water-tight space at the bottom, which will hold sufficient water to surround the bulb; the number of the thermometer in use must be entered at the head of the Column, and any change during the voyage should also be recorded in the Remark Column, No. 25. The water must not be pumped but drawn by a bucket direct from the sea, and in steamers drawn before the ejection pipe. A canvas bucket is generally used, and the thermometer should remain in the bucket for a couple of minutes, it should then be read quickly whilst the bulb is surrounded with water in its metal case. The reading should be taken to tenths of a degree, which is easily done by the eye. 23. Surface temperature.

When water can be brought direct from the sea from a certain depth, either by letting a sea-tap run for some time or by working a pump so long that it brings water direct from the sea, it is interesting to know the temperature and specific gravity of such water, stating the depth at which it was obtained. This observation is especially valuable in the neighbourhood of great changes in the surface temperature, and the temperature and specific gravity of the surface water should be given at the same time. If any great difference is found it should be confirmed by a second observation. The temperature and specific gravity of the sea at great depths is not alluded to here, as it can only be properly done by ships specially fitted for the purpose. Three spare thermometers are supplied, in case those in use as dry and damp bulbs and for surface temperature get broken.

Specific Gravity of Sea Surface. — This observation shows the relative saltness of different parts of the sea. The readings of the scale of the hydrometer increase *downwards;* it sinks to 0 in pure fresh water at a temperature of 60°, and floats at 40 or even higher in some parts of the Suez Canal, where the water is exceedingly salt. It is a rather difficult observation when the ship has much motion, or the surface of the water in the bucket is exposed to much wind. A large well-filled bucket seems to answer the purpose best, and the hydrometer should be slightly spun in the centre; after a minute or two it loses all up-and-down motion, and the scale can be read as it is brought to face the eye by the slight remaining turning motion. The water for trying the specific gravity should also be drawn over the side by a bucket, and its temperature is required at the same time as the specific gravity is obtained. 24. Specific gravity of sea.

The hydrometers supplied by the Meteorological Office are of glass; they should be perfectly clean and dry when used. The number of the instrument in use should be recorded at the head of the Column, and any change during the voyage should be noticed in the Remark Column, No. 25. Metal hydrometers must not be used, as they are liable to oxidize or to get dented, which renders them useless.

Few observers give the specific gravity of the sea more than once a day (at noon) except when in the neighbourhood of current ripples, on each side of lines of foam, &c. &c. In cases of extreme motion it is better to omit than to give a doubtful observation.

Remarks.—On the noon line of each day is given *Current in last 24 hours.* If the Navigator has other opportunities of observing the current they should be carefully recorded in the Remarks, with an explanation of the method used. 25. Remarks. Currents.

If the observations are not sufficiently good for calculating the Current the fact should be stated in the space for currents. Captains are specially requested to calculate the current themselves. See p. 49 for the Instructions on Columns 3, 4, 5 and 6, which allude to currents.

As it is impossible to confine each remark to the line of the hour at which it took place; the hour relating to each remark should be *written* before it. This is very important in the case of a change of wind in direction or force, also in entering the hour when a ship arrives in or leaves port, both of which entries add much to the value of a Log.

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Columns of the Meteorological Log. 25—*continued*

The remarks should contain any important facts, even though they may not at first sight appear related to Meteorology.

They should include the direction *from* which *lower* clouds come *when they do not move with the wind*, stating whether they move fast or slow, also anything very remarkable in the position or appearance of clouds.

Exceptional weather.

Extra observations of the barometer, wind, &c. during cyclones, or other exceptional weather, carefully stating the hour. In such cases the space of several days may be taken for one, and, if thought requisite, the remarks may extend across the whole Log.

Lightning. Corposants. Aurora. Zodiacal light. Falling stars.

The name and bearing of Lightning. The appearance of Corposants, their position and duration, whether they flit about or remain steady, Aurora, Zodiacal Light, Falling Stars, stating in what constellation the last appear, the direction and speed of their falling, the number in a given time, how long they last, how they disappear, and whether they leave tracks.

Waterspouts. Temperature of Rain.

Waterspouts and any facts connected with their formation, rotation, track as related to the wind, and disappearance. Temperature of rain *just fallen*, and that of the air by the *dry* bulb at the same time, seeing that it is dry.

Various.

Halos, Red Fog, Showers of Dust, Earthquakes.

Sea.

Current or Tide Ripples, Discoloured or Luminous parts of the sea, Ice, Seaweed, Drift Wood, Current Bottles, Wreck, &c. &c.

Natural history.

Land or Sea Birds, Insects, or other creatures of land or sea, and the direction in which they are travelling. For instance, Whales, Black Fish, Porpoises, &c.; also fish, such as Albicores, Bonitos, Dolphins (*Coryphæna*), Flying Fish, Sharks, and especially shoals of Herrings, Mackerel, Pilchards, &c., giving the temperature of the sea they are in, and the direction towards which they are going.

Hydrography.

Well-confirmed Hydrographical Notes, such as bearings, soundings, &c., which do not agree with the best charts. The times of high water on full and change days, and amount of rise and fall, direction of tides and currents, &c., when they are not already known.

Nautical experience.

Navigators who have much experience of particular routes are requested to devote a few pages at the end of the Log to remarks on wind, weather, currents, tides, best routes at the various seasons of the year, &c. &c.

Specimen log.

A specimen page of Log precedes the blank form in each Log Book, which, together with the above Instructions, will, it is hoped, render the keeping of a Meteorological Log easy and interesting.

Conclusion.

In conclusion, it is most earnestly requested that no doubtful entries be made, for Meteorology has suffered most seriously from careless observations, and it should always be remembered that a blank space is *very much better* than a doubtful observation.

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REPORT

OF THE

PERMANENT COMMITTEE

OF THE

FIRST INTERNATIONAL METEOROLOGICAL CONGRESS AT VIENNA.

FOR THE YEAR 1874.

MEETINGS HELD AT VIENNA AND AT UTRECHT, 1873, 1874.

Published by Authority of the Meteorological Committee.

LONDON:
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GENTLEMEN,

I HAVE the honour to submit to you an English translation of the Report of the Permanent Committee of the Vienna Congress, containing the Protocols of the Meetings held at Vienna in 1873, and at Utrecht in 1874, with Appendices, consisting of correspondence, &c. connected with the business of the Committee.

Your obedient Servant,

ROBERT H. SCOTT,

Director of the Meteorological Office and Secretary to the Permanent Committee.

To the Meteorological Committee of the Royal Society.

Nov. 1874.

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REPORT

OF THE

PERMANENT COMMITTEE

OF THE

FIRST INTERNATIONAL METEOROLOGICAL CONGRESS AT VIENNA.

MEETING AT VIENNA, 1873.

Meeting of the Permanent Committee on the 16th September 1873.

MEMBERS OF THE COMMITTEE PRESENT:

MM. Bruhns, Cantoni, Jelinek, Mohn, Scott, Wild, and Buys Ballot (President).

The meeting began at 2.30 p.m.

The PRESIDENT proposed to arrange the course of procedure of the Permanent Committee, and the subjects which had been entrusted to it, in accordance with the decisions of the Congress.

After some discussion the following points were agreed upon by the members:

Form of the Proceedings of the Permanent Committee.

I. Proposals made by members of the Permanent Committee are always to be addressed to the President.

He is to communicate these proposals to the other members, who are to send in their opinions on the subject to the President.

From these written opinions the President is to compile a resumé, which is again to be communicated to the members of the Committee.

In specially important cases the Directors of the individual central institutes are to be put in cognizance of the proposal which has been made and of the resumé above mentioned, in order that they may give their own opinion on the subject before any decision is taken on the matter in question. This, however, is only to be done after a repeated correspondence among the members of the Committee.

II. It was decided unanimously to be desirable that the Permanent Committee should meet in the month of September 1874, at Utrecht.

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III. It is left to the individual members of the Committee, if there be no other source of income available, to apply to their respective Governments for travelling expenses, and for a contribution towards the expenses of the office and printing.

Arrangements of the Committee.

IV. The Directors of the individual central institutes are to be requested on the 1st January, by the President, by a Circular, to send in before the 1st April a report on the carrying out of the resolutions adopted by the Congress.

Similarly the Committee is to give a yearly report of its action.

Both reports are previously to be submitted to the members of the Committee.

With regard to the proposal made by M. Jelinek, in relation to the furnishing of reports on the organization of individual systems of observations, that gentleman will submit a draft circular containing the questions which are to be answered.

V. Each Director is requested to draw up instructions for his system, and to send them to Utrecht before September 1874, with a statement wherein and why they do not agree with the decisions of the Congress.

MM. Jelinek and Wild are requested to prepare a draft for a general scheme of instructions for the organization of meteorological observations on land.

VI. In the first place it is the duty of the individual Directors to communicate the resolutions of the Meteorological Congress to their Governments, and they are at liberty to choose the mode in which this communication is to be made.

Furthermore M. Jelinek will address a request to the Austrian Government to inform, through diplomatic channels, the Governments which were represented at the Congress, and also France, of the decisions of the Congress.

Maritime Meteorology.

VII. With regard to the formation of a sub-committee for Maritime Meteorology, which shall make preparations for the Maritime Conference to be summoned, it was decided to invite from the members who are present MM. Buys Ballot, Mohn, Neumayer, and Scott as members of this sub-committee, and to leave a fifth place in it open for a representative of France, which it is hoped to find in the person of M. Mouchez.

VIII. With regard to the selection of a proper telegraphic code for Telegraphic Weather Reports and Storm Warnings, Messrs. Scott and Wild are requested to draw up a scheme.

IX. With respect to the letters and replies regarding Weather Telegraphy and Storm Warnings, which should be published, MM. Buys Ballot, Neumayer, and Scott, who, as members of the sub-committee appointed at Leipzig for that purpose, have proposed the questions, are requested in the first instance to make a proper selection, and the publishing Committee is then to take care of the further publication of the Report.

Measures towards uniformity.

X. With regard to the best form to be selected for publications, MM. Jelinek and Wild are requested to submit a plan which will be set in circulation among the members of the Committee. It is

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wished to hasten the correspondence so that a definite plan can be settled before the beginning of the year 1874.*

Furthermore, the Directors of the different central institutes should be invited to report on the proposals of the Committee.

XI. With regard to the best method of obtaining uniform Barometers and Thermometers for the individual central observatories, MM. Cantoni and Wild are requested to lay down the necessary conditions.

M. Wild undertakes the comparison, (which will be as perfect as possible,) of Kew Standard Thermometers, which Mr. Scott undertakes to furnish, with the Air-thermometer.

Standard Barometers which admit of the absolute measurement of atmospherical pressure, independently of comparisons, should be constructed for the observatories. The questions as to comparisons by means of travelling Barometers was postponed until the Utrecht meeting.

XII. The members of the Permanent Committee are invited to express themselves on the foundation of an International Meteorological Institution. These proposals of the members of the Committee are to be sent to the President before the end of March 1874, and the resumé which he is to draw up from them should be furnished to the members of the Committee at the latest by the end of May 1874. General International Meteorology.

XIII. The proposal of M. Buys Ballot to establish an International Fund, and thereby organize an International Publication, and new observatories in suitable positions, is to be considered at the meeting of the Permanent Committee in September 1874.

XIV. With regard to the Meteorological station at present in existence at Athens, the Permanent Committee will address itself by its President, and in conjunction with M. Jelinek in the first place, to Baron Sina, in order to urge him to maintain the station in the sense wished by M. Schmidt.

XV. With respect to the stations at present existing on the Suez Canal, the Permanent Committee will address itself through its President to the Suez Company with the request either to publish the original observations in question, or to be so kind as to place a copy of them at the disposal of the Permanent Committee.

XVI. With respect to the proposals of MM. Jelinek and Buys Ballot in regard of the indication of the existence of lengthened series of observations, communication of the normal values deduced from them and copies of others as, for instance, hourly observations and results of self-recording instruments, it seems desirable to the Permanent Committee that a notification of the existence of unpublished observations should be printed.

XVII. The Permanent Committee is to arrange for summoning a future Congress, and is to place the delegates of the present Congress in cognizance of its actions and discussions by continual communications.

Close of the meeting at 3.45 p.m. BUYS BALLOT,
President of the Permanent Committee.

* As it was impossible to adhere to this date, I propose to postpone the consideration and adoption of this scheme until the meeting in September 1874.

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MEETING AT UTRECHT, 1874.

Protocol of the First Meeting, held 10th September, at Utrecht Meteorological Institute.

MEMBERS OF THE COMMITTEE PRESENT:

MM. Buys Ballot (President), Bruhns, Jelinek, Mohn, Scott, and Wild.

The meeting began at 11 o'clock.

The President opened the proceedings by expressing on the one hand his pleasure at the present meeting and on the other his deep regret at the death of Professor Donati, which had occurred immediately after the close of the Vienna Congress. He would only give utterance to the hope that at the present meeting the same desire for general accordance in arrangements would rule as had been manifested at the former meeting in Vienna, and recently in London also.

Mr. Scott was chosen as secretary.

Order of business for the Permanent Committee.

MM. Bruhns, Jelinek, and Wild were requested to sketch out a plan of the order of business for the Permanent Committee.

Programme for Discussion.

After some conversation the following programme for discussion was adopted, for the most part corresponding to the decisions of the Vienna Congress.

Decisions of the Vienna Congress.

I. Communication of the reports which have been received on the carrying out of the decisions of the Vienna Congress:—

Maritime Meteorology. Wind-scales.

II. Report of the sub-committee for Maritime Meteorology.

III. Report on the Force of Wind and comparison of the scales of wind.

Standard Instruments.

IV. On the comparison of standard thermometers and standard barometers. Invitations to the different Directors to furnish reports on the barometers employed in their systems.

Synchronous Observations.

V. Synchronous observations.

Weather Telegraphy.

VI. Storm warnings and exchange of meteorological telegrams.

VII. Telegraphic code.

Instructions.

VIII. Instructions.
Symbols for hydrometeors.
Rain-gauges.

IX. Form of publications.

Publications.

X. Exchange of publications.

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XI. International Institution. — International institution.

α. International Publication.
β. International Fund.
γ. International Stations.

XII. Establishment of stations in distant countries and Reports thereupon. — Distant stations.

XIII. Request to the separate Directors for a notification of the existence of unpublished observations.

I. The following Reports were read:— — Carrying out the Decisions of the Vienna Congress.

From MM.	Coumbary (Constantinople)	-	of	3rd March.
„ „	Sohncke (Carlsruhe)	- -	„	14th „
„ „	Lindelöf (Helsingfors)	- -	„	13th „
„ „	Ebermayer (Aschaffenburg)	-	„	18th „
„ „	Cantoni (Pavia).			
„ „	Kingston (Toronto)	- -	„	12th „
„ „	Fradesso (Lisbon)	- -	„	16th „
„ „	Hoffmeyer (Copenhagen)	-	„	29th „
„ „	Aguilar (Madrid)	- -	„	6th April.
„ „	Buchan (Edinburgh)	- -	„	14th May.
„ „	Mohn (Christiania)	- -	„	31st March.
„ „	Scott (London)	- -	„	1st April.
„ „	Bruhns (Leipzig)	- -	„	15th July.
„ „	Wild (St. Petersburg)	- -	„	4th Sept.
„ „	Jelinek (Vienna)	- -	„	2nd „

Mr. BRUHNS suggested that the above Reports, in so far as they referred to the business of the Permanent Committee, should be printed as Appendix A. to the Protocol of the present meeting, which proposal was adopted unanimously.

II. Mr. SCOTT, as secretary of the sub-committee for Maritime Meteorology, read a letter (Appendix B.), and at the same time handed in the Protocols of the Conference which had been held the previous week at London. — Maritime Meteorology.

Hereupon he was requested to bring the resolutions of the Conference to the knowledge of the public as speedily as possible, *e.g.*, by publication of the resolutions in the newspapers. — Resolutions of the Conference to be immediately published.

The PRESIDENT expressed to Mr. Scott in a special manner the thanks of the Permanent Committee for his exertions in respect of the organization and carrying out of the Maritime Conference, whereby the resolutions of the Vienna Congress in reference to that subject are to be considered as completely satisfied.

III. Mr. SCOTT handed in a paper on this subject which he had published in the second volume of the Quarterly Journal of the Meteorological Society.* — Wind Forces and Wind Scales.

* "An Attempt to establish a Relation between the Velocity of the Wind and its Force (Beaufort Scale), with some Remarks on Anemometrical Observations in general." Quarterly Journal of the Meteorological Society, Vol. II., p. 109.

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MM. BUYS BALLOT and WILD presented Reports which are printed as Appendix C.

Mr. MOHN described a plan for measuring the velocity of the wind which Captain Hoffmeyer had shown him at Copenhagen. It consists of a vertical tube with its upper extremity ground off horizontally, which at the lower end is combined with a manometer. The motion of the air above the upper end of the apparatus produces an aspiration which immediately manifests itself in the manometer by a difference of level in the two legs. He stated that Captain Hoffmeyer was at the present time engaged with experiments with the apparatus.

Experiments to be continued.

The Committee decided that according to the communications which had been made to it the question must be considered as not set at rest, and requested the gentlemen to carry on their experiments.

Standard Thermometers.

M. WILD reported that the two Standard Thermometers, one from Kew, and the other by Geissler, of Bonn, having been verified in the usual manner, had also agreed at 50° C. to within 0°·01 C., and in consequence of that, the doubt which he had formerly had with regard to the accordance of mercurial thermometers with each other had been materially weakened.

On the other hand the comparison of these standard thermometers with the air-thermometer had not been as yet carried out, but he hoped to be able to effect this in the coming winter.

Mr. SCOTT requested permission to read the following remarks* of Professor v. Oettingen respecting another Kew Standard Thermometer, and permission was granted.

Mr. SCOTT further stated that the Kew Observatory was now ready to mark the position of the freezing point of mercury on spirit thermometers which should be sent to them.

M. BUYS BALLOT remarked that the comparison of the thermometers at one and the same central establishment was specially desirable. The Permanent Committee repeated their conviction of the urgent desirability of this comparison.

M. BUYS BALLOT informed the Committee that the Batavian Society of Natural Science had invited the members of the Permanent Committee to their anniversary festival to be held on Saturday. The members of the Committee expressed their thanks for the invitation, and at the same time stated their extreme regret that owing to the amount of work to be done they were unable to accept it.

Close of the sitting at 4.30.

BUYS BALLOT.

---

* Dr. A. v. Oettingen, University, Dorpat, March 12, 1874. "By separating a thread of quicksilver I was able to test the calibration, and I find differences which are hardly measurable, at the most 0°·02 Fahrenheit. Such a tube and graduation has in fact never come before me."

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Second Meeting, 11th September, 10.30 a.m.

PRESENT:

M. Buys Ballot (in the chair), MM. Bruhns, Jelinek, Mohn, Wild. Mr. Scott, Secretary.

Letter from Professor Cantoni.

The PRESIDENT read a letter from Professor Cantoni, in which he expressed his regret that he was unable to take part in the Conference.

Barometers.

IV. Mr. WILD submitted a paper on the determination of atmospheric pressure, which he had published in the third volume of the "Repertorium für Meteorologie."*

M. WILD drew attention to the fact that if we speak of the comparison of standard barometers at central stations, and wish to attain an accuracy of 0·03 mm., the usual travelling barometers would not be sufficient, but that syphon barometers of a diameter of at least 12 mm. were requisite, in which, moreover, the mercury should always be caused to rise in both legs, immediately before the reading.

Purification of Mercury, &c. Weinhold's apparatus.

He also specially recommended for the purification of mercury and the filling of barometers, the apparatus proposed by Professor Weinhold, and described in Carl's "Repertorium für Physik," Vol. IX., p. 69.

Description of English Barometers.

Mr. SCOTT stated that the barometers in use in England were already described in the "Barometer Manual" (1871).

Reports on other Barometers.

In order to obtain information as regards the barometers which are employed in the various systems of observation, questions with reference to this subject should be included in the circulars, by which the Directors are requested to furnish reports on the organization of their systems of observation (*vide* Appendix E.).

Simultaneous Observations.

V. It was reported that General Myer had for a considerable time received simultaneous observations for 0h. 43m. Greenwich Mean Time for the majority of European countries. The Committee decided to invite the Directors of the various systems of observation to include in their reports a short statement of the participation of the different countries in this organization.

Publication of Synchronous Observations.

Reported that the simultaneous observations for the North American stations were already published by the Signal Office, but for the stations in Europe, Asia, &c., the only publication in existence is that for Russia.

It seems, therefore, desirable that all observations of that kind should be made available for the use of Meteorologists in a special publication.

Weather Telegraphy and Exchange of Telegrams.

VI. Mr. SCOTT handed in the Report of the Leipzig Sub-committee to the Vienna Congress respecting "Weather Telegraphy and Storm Warnings," both in English and German.

The following resolution on this subject was adopted:—

> In consideration of the resolutions adopted at the Vienna Congress, and the Report of the Sub-committee which has

* "Ueber die Bestimmung des Luftdrucks," Repertorium für Meteorologie, Vol. III., p. 1.

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just been published, the Permanent Committee is of opinion that it is in the first place the business of the several Directors to take the steps which are requisite in order to obtain Telegraphic Weather Reports from foreign countries, and, in this question, attention must be paid to the importance of the position of the stations for storm-warnings, and the number of stations must be confined to the lowest number requisite.

It seems desirable that the gaps which are still found in the Telegraphic Weather Reports of different countries should be filled up, in order to be able to proceed to the organization of Storm Warnings wherever these do not exist.

Furthermore, according to the proposal of M. Buys Ballot (*see* Appendix to the Report in question), in the case of atmospheric disturbances, communications should be made by the individual directors in special telegrams, according to the English method, with regard to the barometric differences, whenever these exceed a given limit, with a statement of the stations whence the respective observations have been reported, and with a remark as to whether or not a strong wind is blowing anywhere in the country.

Telegraphic Code.

VII. The Sub-committee appointed at Vienna (MM. Scott and Wild) submitted their Report on a Telegraphic Code.

M. JELINEK also submitted a proposal for a Telegraphic Code devised by Professor Osnaghi. The consideration of this question was postponed for the present.

Major Kromhout's apparatus for Signals.

The PRESIDENT exhibited a model of a new Signal apparatus invented by Major Kromhout, by means of which it is rendered possible to give, in a simple and unmistakeable way, 54 different signals to a considerable distance.

Instructions.

VIII. The decision of the Congress with reference to general Instructions can, in the opinion of the Committee, best be carried out in the following way, viz., that the Committee should institute a comparison between the Instructions which are to be prepared afresh by the individual Directors, and should point out those which in its opinion are most in accordance with the decisions of the Congress.

The Permanent Committee expresses the wish that all Directors should be invited by a Circular to send in the Instructions which are at present in use in their districts.

Rain-gauge.

In consideration of the objections which have been raised by Mr. Symons and other Meteorologists against the dimensions of the rain-gauges proposed by the Meteorological Congress, and with regard to the necessity of the establishment of numerous rain-stations, which should be fitted out with simple instruments at moderate cost, it seems to the Permanent Committee to be advisable to recommend the next Meteorological Congress to con-

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sider afresh the questions regarding the dimensions and the height above ground of rain-gauges.

IX. The Permanent Committee recommends that all parcels should be sent, if possible, by book-post. The Directors are requested to give in their Publications a list of the Institutes with which they stand in connexion, and the Publications which they receive. Exchange of Publications.

The sitting was adjourned at 5 o'clock.

BUYS BALLOT.

Third Meeting, 12th September, 10.15 a.m.

PRESENT:

M. Buys Ballot (in the Chair), MM. Bruhns, Jelinek, Mohn, Wild. Mr. Scott, Secretary.

Received:

The autographic records of the meteorograph of Professor van Rysselberghe, of Ostend.

A pamphlet from M. E. H. v. Baumhauer, "Sur un Météorographe universel destiné aux Observatoires solitaires."

A description of a balance hygrometer, by M. Snellen, as a modification of Baumhauer's hygrometer.

A letter from M. Cantoni.

The order of business of the Permanent Committee which was mentioned at the first meeting was submitted by the sub-committee to whom it had been entrusted, and was adopted unanimously. Order of business.

Submitted—A circular proposed by M. Jelinek to the different Directors with regard to the organization of their Institutes, &c., which was also adopted (Appendix E.) Circular to Directors.

IX. With reference to the form of Publications, the following proposal which had been devised according to the deliberations of the Committee and revised by M. Wild was adopted. Form of publications.

The Congress at Vienna, at its meeting of the 15th September 1873, adopted two resolutions, which, when read together, run as follows:

> "Each Director is to choose in his own district a number of stations for international objects and, for the publication of observations, is to adopt a common form (within the limits laid down by the hours of observation), which form is to be proposed by the Permanent Committee, after inquiry from the Directors of the Central Offices."

After numerous explanations and a long discussion the Permanent Committee proposes *unanimously* the following definite arrangement of the material for the publication of observations

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taken two or three times a day, for the stations of the second order, which are selected in each country :—

Name of Station. Year. Long. from Greenwich.
Height above sea. Month. Lat. „

Date.	Barometer.			Air Temperature.					Vapour Tension.			Relative Humidity.			Wind, Direction, and Force.			Cloud.			Rain.	Remarks.
.	7	1	9	7	1	9	Min.	Max.	7	1	9	7	1	9	7	1	9	7	1	9	—	≡ 3
1																						
2																						
3																						
Mean																						

See Appendix F.

If the language of the country is other than German, French, or English, the headings of the columns are to be given in one of these languages, in addition to the special language of the country.

In these monthly tables the maxima and minima of pressure and temperature are to be given by Egyptian figures.

In the relative humidity, perfect saturation can either be given by three figures (100) or, by omitting the figure (1), by giving only the two figures (00).

In the column "Remarks," it is desirable, in order to indicate the duration or the epoch of hydrometeors, &c., to employ symbols which are generally intelligible, and accordingly to add to the respective symbols for hydrometeors either the hour of the beginning and end, in which the forenoon hours are marked *a* (a.m.) and the afternoon hours *p* (p.m.).

● 10 a — 4 p would therefore indicate "rain from 10 a.m. to 4 p.m., civil time;" or where this is not possible, to give by means of additional figures, 1, 2, or 3, whether the hydrometeor in question had occurred at or before the 1st, 2nd, or 3rd period of observation. ≡ 3 would indicate "fog at or before the 3rd period of observation" about 9h. or 10h. in the evening; ≡ 1·3 would mean "fog at the time or before the first and last periods of observation, *i.e.*, morning and evening."

As to the further order or arrangement of the individual monthly tables of this form in the annual volumes of the Central Offices, the majority of the Committee thinks that at present it should be left to the editors of these books whether they will, as has been hitherto generally the case, print the tables for each station for the same month one after another, in which case monthly parts may be issued; or whether they, as will be the case in future in Norway, Sweden, Denmark, Austria, Russia, and

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Saxony, will only give complete yearly volumes, in which the 12 monthly tables for one station, arranged in pairs one under another (4 months to one opening), should follow immediately one after another (*see* the specimen in Appendix F.)

In accordance with the wish of several Directors of Central Institutes, the Committee thinks it desirable to give an *inferior limit* for the number of stations of the second order, which are at least necessary for the study of the general phenomena of weather in each country, and observations from which should be published in extenso in the method above given.

Country.	No.
Norway - - - -	10
Sweden - - - -	10
Denmark, with Iceland and Färoe -	6
Great Britain and Ireland - -	15
Russia in Europe - - -	50
Russia in Asia - - -	100
Netherlands - - - -	2
Belgium - - - -	2
Germany - - - -	12
France - - - -	12
Austria and Hungary - - -	15
Turkey - - - -	10
Switzerland - - - -	5
Italy - - - - -	12
Spain, Portugal, (and Azores) - -	12
Greece - - - -	3

It remains open for the Directors of the individual systems not only to select the stations which are best suited for the purpose, but also to increase at pleasure the minimum number above given.

For the publication of monthly and yearly resumés for all stations of the second order, the Committee proposes the following form which has been devised by Dr. Jelinek. (*See* Appendix F.)

For want of room the 16 wind directions are reduced to eight. This reduction is to be made in the same way as that from 32 directions to 16, according to the resolution of the Congress on the 11th September 1873.

The definition of clear and cloudy days is:—

"Clear" when the mean cloud - < 2
"Cloudy" „ „ - > 8

The number of days with aurora, with the maximum temperature under or equal to 32° (days without thaw), and with the minimum of temperature under or equal to 32° (days of frost), further the giving of the mean force of the wind &c. may, when there is room, either be included in these tables, or even given specially with other remarks in the Appendix to the yearly volume.

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These tables are to be given apart from the former ones in the yearly volume.

As for the means of daily Humidity and Pressure it seems desirable to arrange the calculation so that they shall accord as nearly as possible with true daily means.

With regard to the form of publications of *other* meteorological observations of each country the Committee thinks that it should leave the most perfect freedom to the Directors, and therefore confines itself to expressing a few wishes with respect to their completeness. In order to facilitate the study and examination of recent weather phenomena, it would be very desirable if from the Central Offices of all great countries, or even according to the example given by Sweden, Norway and Denmark, in their "Bulletin du Nord," from the central offices of several countries together, *daily meteorological bulletins* should be published based on their Telegraphic Weather Reports even if they are only copied on tracing paper, and without synoptic charts.

The Observatories of the first order also should render their observations more generally available, by means of copying, and it seems especially desirable for the reduction of the term observations, and for the study of individual special phenomena of weather, that all observatories furnished with self-recording apparatus should reduce in extenso, and give hourly values of, the most important meteorological elements (for local time) for a number of years, and at the same time it is recommended that, as regards Humidity, not only the wet bulb thermometer should be given, but also, if possible, the calculated values of Vapour Tension and Relative Humidity.

The meeting closed at 4.30 p.m.

BUYS BALLOT.

Fourth Meeting, 14th September, 10 a.m.

PRESENT:

M. Buys Ballot (President), MM. Bruhns, Jelinek, Mohn, Wild, Mr. Scott (Secretary).

A letter from Professor G. Cantoni, dated 8th September (Appendix D.) was read.

Telegraphic Code.

VII. The discussions on the code for Meteorological Telegrams were continued. A Report consisting of six groups of five figures each was proposed for each station.

The PRESIDENT asked whether it would not be possible to reduce the six groups to five, since one group daily per station necessitated an amount of labour and expense not to be neglected.

Also, whether with regard to this the Continental system (metres) or the English system (inches) can be changed.

M. JELINEK thought it desirable to retain the six groups generally, to correspond to the English system which had already been tested by use, but there was no reason why those stations which were unable to furnish the whole of the data required should not omit the sixth and even the first and second groups.

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After much consideration the following system was agreed upon:—

1°	2°	3°
*B *B *B *W *W	*S *S *H *T *T (Eng.) *S *H *T *T *T (Cont.)	B B B W W

4°	5°	6°
S S H T T (Eng.) S H T T T (Cont.)	T′ T′ R R R (Eng.) T′ T′ T′ R R (Cont.)	M M m m Sea

* Data refer to the previous evening.

Decimal points are always disregarded, and in the case of the barometer the first figure is also omitted, as this must, under ordinary circumstances, be 7 for continental stations (millimetres), or either 2 or 3 for British stations (inches). Thus:—

763·5 mm.	is telegraphed as	635
29·34 in.	„ „	934
30·03 „	„ „	003
25°·3C	„ „	253

and for Temperature:—

B=Air pressure at sea level and 32° F. and to 0·1 mm. or 0·01 in.

T=Dry bulb thermometer to 0°·1 C or 1°·0 F.

T′=Wet bulb thermometer to 0°·1 C, or 1°·0 F. For temperatures below 0° 50° C are to be added. In other words, with Temperatures below 0° C, no sign (+ or −) is to be used, but the reading is to be increased by 50. So, *e.g.* for − 5°·3 C, 553 would be telegraphed.

M.=Max. } Temperature, to 1°·0 C, or 1°·0 F.
m.=min. }

W=Wind direction (*true*, not magnetic) referred to 16 of the 32 points, being only the even numbers:

N = 32, E = 8, S = 16, W = 24.

S=Wind-force (Beaufort scale).* For the continent, when the force

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* This is estimated in accordance with the following scale, known ordinarily as the "Beaufort Scale," from its having been drawn up by Admiral Beaufort for use on board ship. The Scale has been altered so as to suit the present use of double topsails. Added to the Table is a list of the *average* values in miles per hour travelled by the wind during the prevalence of the different forces.

Beaufort Scale of Wind Force.			Miles per Hour.
0. Calm			3
1. Light air	Or, just sufficient to give steerage way		8
2. Light breeze	Or, that in which a well-conditioned man-of-war, with all sail set, and clean full, would go in smooth water from	1 to 2 knots	13
3. Gentle breeze		3 to 4 knots	18
4. Moderate breeze		5 to 6 knots	23
5. Fresh breeze	Or, that to which she could just carry in chase, full and by	Royals, &c.	28
6. Strong breeze		Topgallantsails	34
7. Moderate gale		Topsails, jib, &c	40
8. Fresh gale		Reefed upper topsails and courses.	48
9. Strong gale		Lower topsails and courses.	56

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exceeds 9, this figure will be recorded in the proper group, and at the end of the telegram the force should be repeated in words.

R=Rain to 1mm. or 0·01 in. In the Norwegian Telegrams in winter 99 means "Fall during the night" without its being measured.

Sea=Sea disturbance 0—9.

0 = dead calm.	4 = moderate.	7 = high.
1 = very smooth.	5 = rather rough.	8 = very high.
2 = smooth.	6 = rough.	9 = tremendous.
3 = slight.		

H=Hydrometeors or weather, as follows:

0	State of sky	Quite clear.	5	Rain.
1		¼ clouded.	6	Snow.
2		½ „	7	Dust-haze (Höhenrauch.)
3		¾ „	8	Fog.
4		Overcast.	9	Thunderstorm.

The occurrence of Hail, Sheet Lightning, Aurora, &c., should be added in words at the end of the telegram.

Instead of the Maximum the Temperature at 2 p.m. can be given.

If there is no Minimum thermometer at a station and the Sea disturbance is not observed, the sixth group is omitted.

The data for pressure, temperature, wind direction and force, are in the British Isles for 6 p.m. and 8 a.m.; for the Continent for 9 p.m. and 7 a.m. in general.

International Institution.

XI. Submitted the letters addressed to the President on this subject, which are contained in Appendix G, as well as a letter from M. Plantamour to Mr. Scott, dated 24th August.

M. Bruhns made the following proposals, of which the first and second were adopted:—

The Permanent Committee has discussed the various proposals on the International Institution (*see* Appendix G.), and has come to the decision:—

1. That at the present time an institution of definite organization, and established by international contributions, cannot be carried out.
2. Nevertheless the Committee considers it possible and suitable to support individual investigations in the department of International Meteorology, according to the means at its disposal.

In the place of the third resolution:—

"The Permanent Committee commences with an international publication, which should be the organ of the

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10. Whole gale	- Or, that with which she could scarcely bear lower main-top-sail and reefed foresail.	65
11. Storm -	- Or, that which would reduce her to storm-staysails -	75
12. Hurricane	- Or, that which no canvas could withstand - -	90

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Permanent Committee, and should contain in the first place the European simultaneous observations, in so far as they are necessary to afford a general view of the atmospherical phenomena, and furthermore should include papers and charts of a nature strictly scientific, and advancing the science of Meteorology. The editing is to be undertaken by the Permanent Committee."

The following resolutions proposed by M. JELINEK were adopted:

3. The Permanent Committee will endeavour to forward the Publication, and the sale of the Synchronous Charts published by M. Hoffmeyer in the proper way.
4. The Permanent Committee will endeavour to collect synchronous observations from Europe, Asia, &c.; will provide means for their publication, and will entrust some gentleman, to be named, with their revision and publication in a form which will be generally agreed upon.

Distant Stations.

XII. With regard to the establishment of distant stations the following communications were submitted—

(*See* Appendix H.)

It was decided that a letter should be addressed by the President to M. de Lesseps, to express to him the thanks of the Committee for the numerous meteorological communications received from his Suez Canal stations, and at the same time to request him to be so kind as to allow them to be continued.

The meeting closed at 4.45 p.m.

BUYS BALLOT.

Fifth (and last) Sitting, 14th September, 7.45 p.m.

PRESENT:

Buys Ballot in the chair, MM. Bruhns, Jelinek, Mohn, Wild, Mr. Scott, Secretary.

M. Jelinek's proposal. Unpublished Series of Observations.

M. JELINEK submitted a circular (Appendix I.) with respect to his proposal (*see* Report of the Vienna Congress, Appendix III., 3), which was adopted.

Any answers thereto which may be received will be included in the next Report for 1875.

Notification of the Vienna Resolutions to Governments.

With respect to the VI. resolution of the Permanent Committee of the 16th September 1873, M. JELINEK answered that he, in the Report which he had furnished to his Government about the Meteorological Congress, had included the request that it would place the Governments which had been represented at the Congress, as well as the French Government, in cognizance of the resolutions of the Congress by diplomatic channels, and to this end he had supplied to his Government a number of copies of the Reports of the Congress.

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Furthermore he had sent to all the most eminentFrench meteorologists copies of the French edition of the Report of the Congress, and that there was reason to suppose that this Report had in this way been brought to the knowledge of the French Government.

Co-option of members not carried out.

With respect to increasing the number of the members of the Permanent Committee, which had been sanctioned by the Vienna Congress (*see* Report of the 13th September), it was decided that it did not seem at present necessary to co-opt any more members.

Publication of the Protocols.

It was decided that the protocols and appendices should be published in three languages (English, French, and German).

The proposal of M. Wild that a brief summary of the resolutions of the Vienna Congress should be appended to the Report of the Permanent Committee was adopted, and the preparation of it was entrusted to M. Wild (App. K.).

It was further decided that the German edition of the whole Report should be printed at Leipzig under the care of M. Bruhns.

Mr. Scott undertook the English edition, while the French was undertaken by M. Buys Ballot.

Publication of synchronous observations.

The publication of synchronous observations will be undertaken by M. Buys Ballot from the 1st January 1875, on the understanding that the requisite funds will be placed at his disposal.

Next meeting.

As to the place and time of the assembling of the next meeting of the Permanent Committee, which at the latest must be in the spring of 1876, the votes of the members are to be ascertained by circular.

Secretary chosen.

The Permanent Committee, in accordance with the order of business which has been adopted, requests Mr. Scott to act as Secretary until the time of the next meeting.

M. Buys Ballot thanked all the members for their attendance at the meeting and for their unwearied activity, by means of which many useful resolutions had been obtained which would tend to advance general meteorological investigations, and he especially thanked Mr. Scott in the name of the Permanent Committee.

The Committee expressed its thanks to its President, M. Buys Ballot, and to the Government of the Netherlands, for the kindly reception which had been given to them, and requested M. Buys Ballot to convey the expression of these thanks to the Government.

Close of the meeting at 10 o'clock.

Buys Ballot.
C. Bruhns.
H. Mohn.
C. Jelinek.
H. Wild.
Robert H. Scott, *Secretary.*

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APPENDIX.

APPENDIX A.

CIRCULAR.

SIR, Utrecht, Dec. 31, 1873.

IN accordance with the wish expressed by the Permanent Committee for International Meteorology, I have the honour to remind you by this Circular that the Congress at Vienna has thought it desirable that the decisions which have been taken should be observed as closely as possible, and that you should be invited to send to the Permanent Committee a report on the changes introduced in your country in conformity with these decisions, or, if these changes have not taken place, a communication of the motives which have prevented you from carrying them out.

The Committee requests you to forward your reply to me before the 1st April next, so that I may be able to prepare a general *resumé* of the various answers, in order to communicate the same to the members of the Committee.

I shall not remind you of all the resolutions which you will find enumerated in the *Bericht des Meteorologen-Congresses in Wien;* it will suffice to mention some of them.

It would be superfluous to call your attention to the reports of the sub-committees on the different instruments of observation, for I am sure that, before attending at the Congress, you were convinced as a physicist, that the most perfect instruments were the only ones that should be employed. The time also was too short to discuss the reports thoroughly with the 30 members of the Congress, and moreover every year may bring improvements in each instrument, so that uniformity can scarcely be obtained, except as to the plan of publishing the observations.

It would therefore be desirable, in the first place, to know what instruments you use, and if you have been able to assure yourself of the existence of compared instruments in the other observatories of your country.

As to the publication of the observations, a plan will be proposed to you, at the same time you will be invited to report on the advantages or disadvantages of monthly or annual publication. As to the form of the symbols, I have to remind you that in case you do not make use of arrows for indicating the Direction of Wind, as recommended at the Leipzig Conference, and that you use letters, it is decided that from the beginning of next year the English designations N., N.N.E., N.E., E.N.E., E., E.S.E., &c. will be used.

The amount of Clear Sky will not be noted, but the amount of Cloud, so that an entirely overcast sky will be indicated by the figure 10, and a perfectly clear sky by 0.

The year will commence on 1st January, and all the months will begin with the first.

The day will begin at midnight, and the hours will be indicated by 0—12 a.m., and 0—12 p.m.

Further it is recommended to calculate the mean temperature for five-day periods, on the authority of M. Dove.

After each Lustrum, commencing with the year $5n + 1$, the observations will be grouped in tables, in order to be able better to compare the results obtained by other observatories.

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This conformity in the small details is in the first place very desirable for the observatories, whose observations are to be grouped in tables to give a general *resumé* of the great atmospherical movements over the whole globe. For while introducing uniformity into what is necessary, perfect liberty must be given in doubtful matters.

Further you are requested to use the centigrade scale for the thermometer, and the metric system for the barometer, or at least to give the mean values in this scale, since it is desirable to avoid reductions. We might commence by rejecting Paris lines in every case.

As to International Meteorology, I have the honour to inform you that the Permanent Committee has received a very favourable reply from M. de Lesseps respecting the observations made on the borders of the Suez Canal. Mr. Hart has made a proposal of a more vast extent than that of which we have taken cognizance at Vienna, for the establishment of observatories on the eastern coasts of China, in connexion with the stations of Yokohama, Nagasaki, and Batavia, a project which I have greatly approved.

I have founded an observatory at Djeddah, on the Red Sea, and I hope that you also, sir, will have found means of establishing an observatory at some remote place, a new link of the network which is to cover the whole earth, or that you will be able to state that your Government, like that of Portugal, not to mention a smaller State, is disposed to establish observatories beyond its own limits.

This appears to me to be of the highest importance. It is above all necessary to found new observatories at well selected points of the globe.

Every observation or communication on your part respecting the points mentioned in the report of the Congress cannot be but very acceptable to the Permanent Committee.

(Signed) BUYS BALLOT.

To the Director of the
Observatory at

REPLIES,

A. COUMBARY, Imperial Meteorological Observatory, Constantinople.

I HAVE the honour to acknowledge the receipt of your circular dated 31st December 1873, and to reply to all the questions contained in it.

The instruments of observation which the Observatory of Constantinople possesses are: —

A standard barometer, large size, on Fortin's principle, reading to hundredths of millimetres, made by Tonnelot, and compared at the Paris Observatory.

A small size barometer, on the same principle.

A self-registering barometer, on Hipp's principle.

A self-registering thermometer, on Hipp's principle.

A Robinson's anemometer, with electrical registering apparatus, giving the velocity of the wind.

A rain-gauge, with circular receiver of 22 centimetres diameter, placed at 10 metres above the ground.

Our maximum thermometers are Walferdin's, with an air bubble, and the minimum are Rutherford's spirit thermometers, made by Baudin.

August's psychrometers, made by Baudin and Kappeller.

The observatory room is 80 metres above sea level.

The exposure and the mode of setting up the thermometers having a great influence upon the degree of temperature recorded, we have established various methods of exposure; some are simply sheltered by a wooden pent-house roof, others are fixed in iron screens painted white.

The thermometers fixed in screens are those used for printing in our tables.

The thermometers are often compared with the standard thermometer made by Baudin, and reading to tenths of degrees.

The barometer observations, recorded in millimetres and tenths of millimetres, are reduced to 0°C and to the sea level.

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The observations are made regularly at 8 a.m., 9 a.m., and 2.39 p.m. (the time of the simultaneous observations), and at 6 p.m.

The thermometer observations are grouped into 5-day means.

The amount of cloud is noted from 0 to 10.

We make use of the English denominations for the Direction of the Wind.

The stations of the Ottoman meteorological system have been organized with a view to dynamical meteorology, and with this object the barometric differences suffice. The stations are provided with aneroids; the transit of mercurial barometers would have presented great inconveniences, owing to the difficulties of conveyance, in the interior of the country; consequently we have been obliged to abandon it. At these stations an observation is made at 8 a.m.; it embraces the barometric pressure, temperature, and direction and force of the wind.

At all these stations the instruments are compared with standards as often as possible.

Besides the simultaneous observations taken at Constantinople, such observations are also taken at four other stations of our system, viz:—Varna (Black Sea), at 2.35 p.m., Valona (Adriatic) at 2 p.m., and at Fâo (at the north end of the Persian Gulf) at 4 p.m. These three stations send us the observations daily by telegraph. Lastly, a fourth station has been established in Yemen, at Hodeïda, on the Red Sea, where the observations are taken at 3.36 p.m. The observations of this latter station are sent to us by post monthly, but we hope soon to receive them also by telegraph.

These stations, like all the others of our system, also send us observations taken at 8 a.m.

We also hope soon to have simultaneous observations made at other stations.

Dr. Sohncke, Meteorological Central Station, Carlsruhe.

1. Agreeably to your request of the 31st December, 1873, I beg to inform you, as President of the Permanent International Committee, that from the beginning of this year I have had our observations taken in all respects in accordance with the decisions of the Vienna Congress. The few changes which had to be made, in consequence of the decisions of the Congress, in the system of observations of the Grand Duchy of Baden, one of the latest organized may be seen from the accompanying "supplement to the instructions"* issued to the observers of Baden, which I have drawn up. I have also somewhat altered the Summaries of Results which appear monthly in the Carlsruhe Journal, and used there *e.g.* the letter E. for East.

2. The instruments of observation are precisely the same as those introduced into Switzerland by Professor Wild when he was there, viz.:—1°. Cistern barometer graduated to millimetres and with vernier (the diameter of the cistern is about 100 times as large as that of the tube). 2°. Thermometer graduated to 1/5 degree (centigrade). 3°. August's psychrometer, in tin case, with perforated sides and top. 4.° Rain gauge, with circular receiver of about 250 millimetres in diameter; 5. Wind-vane, with Wild's metal plate for measuring the force of wind. All the apparatus is made by Hermann and Pfister of Berne. Maximum and minimum thermometers existed formerly, viz: Hermann and Pfister's metallic spirals, but all of them have become corroded and unserviceable. I have ordered from Greiner, of Munich, maximum thermometers of his latest construction, and alcohol minimum thermometers.

The barometers and thermometers at all stations are examined yearly during the tour of inspection, and the reduction of all barometers is constantly checked by that of the station at Carlsruhe.

L. Lindelöf, Secretary of the Society of Sciences of Finland, Helsingfors.

The Society of Sciences of Finland has received, through M. Nordenskiöld, your circular of the 31st December last, addressed to the Directors of meteoro-

* In other respects we have introduced the Swiss Instructions.

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logical establishments of all countries, and by which each is invited to send to the Permanent Committee a report on the changes introduced in the meteorological service of his country in compliance with the decisions of the Congress of Vienna. Wishing to profit by this opportunity to put itself in relation with the Permanent Committee, the Society of Sciences has directed me to give the information which you desire, in so far as regards the system of observations organized under its auspices in Finland.

It is perhaps necessary, in the first place, to remark that these observations are made solely by amateurs who, in the interest of the science, have offered their gratuitous co-operation to the society. The latter simply furnishes them with instruments and forms for the observations.

The first meteorological stations, five in number, were established in 1846, on the initiative of M. Nervander, of whom the science was deprived soon afterwards by a premature death. Other stations have been added successively, so that at present there are 20, dispersed over different parts of the country. (They do not depend upon the magnetic and meteorological observatory of Helsingfors, which is a government establishment). Each station is, generally, provided with a barometer and two thermometers, graduated respectively to millimetres and degrees centigrade, and the observations are made three times daily, at 7, 2, and 9. In this we have therefore nothing to change to conform to the wishes of the Congress. At a small number of stations we have made hygrometrical observations for two years, but these require too much care in our climate, especially during winter, to allow of our trusting much to their accuracy.*

The instruments are of sufficiently good quality, but they can only be compared at very long intervals, on account of the great distance of the stations and of the difficulty of conveyance. The last comparison was made in 1871, by M. Limström, who was sent by the Society to inspect all the meteorological stations as far as Lapland.

In addition to this system of observations, which requires instruments of precision, the Society of Sciences has established another with a view to obtaining as much information as possible on natural phenomena of every kind which can be observed without instruments, and which may serve to indicate the climate. (Such are:—the state of the sky, winds, rain or snow, aurora-borealis, thunderstorms, freezing and thawing of lakes and rivers, blossoming of trees and plants which are best known, development of their fruits, &c). The Society supplies registers for recording these facts, and they are returned yearly.

As to the publication of purely meteorological observations, it is limited at present to one volume, containing the thermometrical observations of the years 1856–65, published by our Statistical Office, and inserted in the series of the "Bidrag till Finlands Officiela Statistik, V." It contains means of temperature calculated by M. Nordenskiold, for every five days and for every hour, &c.

The climatological notes made during the years 1846–55, have been collated by M. Moberg, in two volumes, under the title of "Klimatologiska iakttagelser i Finland," published by the Society of Sciences in 1860 and 1871, in "Bidrag till Finlands naturkännedom, VII.," and "Bidrag till kännedom af Finlands natur och folk, XVIII."

Hitherto the Society has not been in a position to undertake the regular publication of the observations which it continues to collect, but it hopes soon to obtain the necessary funds for doing so, the Diet having voted a sum to be placed at its disposal for meteorological services.

Henceforward it will doubtless do all it can to give to these services a greater perfection and extension agreeably to the decisions adopted by the Meteorological Congress.

To complete this brief report, I shall add a few notes respecting our Magnetic and Meteorological Observatory. This Observatory, founded in 1844, had M. Nervander for its first Director. Its present Director (since 1848) is M. Borenius. Until the year 1856 observations were taken every 20 minutes, after that time every hour (day and night). The observations, both magnetic and meteorological, of the years 1844–7 have been published in four volumes, of two parts each, at the joint expense of the Imperial Academy of Sciences of St.

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* From four stations (without counting the Meteorological Observatory of Helsingfors) telegraphic reports are sent to the central Physical Observatory of St. Petersburg.

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Petersburg and of our Society. The first volume contains a detailed description of the instruments and methods of observation which are still in use. This series has just been continued by a fifth volume, published last year, (also at the expense of the Society) by M. Nordenskiöld, and containing the temperature observations of the years 1848–56. In addition, the mean values for several years, calculated from the observations of our Meteorological Observatory, by the present Director, will be found in the "Annales de l'Observatoire Physique Central de St. Petersbourg (Correspondance Météorologique) and in the Comptes-Rendus (Öfversigt) of our Society.

In concluding this sketch of the meteorological works executed in Finland it will perhaps not be useless to mention a further series of thermometric and barometric observations made at Helsingfors 1829–43, with great care by M. Hällström and which have not been published in detail. M. Hällström has utilised a portion of them in his memoirs on the Climate and Atmospheric Pressure of Helsingfors, contained in Vols. I and II of the "Acta Societatis Scientiarum Fennicae."

Dr. E. Ebermayer, Royal Academy of Forestry, Aschaffenburg.

In reply to your circular of 31st December last, I beg to report to you the proposals made by me to the Bavarian Government (Ministry of Public Worship) with reference to the organization of the Meteorological System of Observations in Bavaria.

With respect to the decision of the International Meteorological Congress of Vienna, that in each country at least one Central Station should be established for the direction, collection, and publication of Meteorological Observations, I explained the reasons for the establishment of a Meteorological Central Institution in Bavaria, and pointed out especially that hitherto, among all other countries, Bavaria has taken the least part in Meteorological Observations, and that therefore several stations of the Second and Third Order ought to be established.

As such a want has already existed for many years, and as the Bavarian Academy of Sciences has interested itself much in the matter, there can be no doubt that my proposal will be complied with at head-quarters. The Minister of Education has already referred my communication with its appendices to the Royal Academy for their opinion.

There is consequently ground for hope that in a short time Bavaria will place the Meteorological Service on a solid basis, and that our Government will adhere to the decisions and wishes of the Congress.

Committee of International Meteorology in Italy. Communicated by Prof. J. Cantoni, Royal University, Pavia.

The importance of the deliberations of the International Congress of Vienna for Meteorology has already been brought to the knowledge of this Ministry by the report presented by its own delegate at this Congress, Prof. Cantoni, and you have also set it forth still better in the valuable communications which you have obligingly sent to our Secretary, and for which we thank you exceedingly.

You will have received a copy of the Resumé of the Observations made during seven years at many of the Meteorological Stations of Italy. This paper contains the rules followed in the Observations, the state of the instruments employed, and the principal results, illustrated by some tables. We have thus replied by this Resumé to the first of the wishes expressed in your circular of the 31st December.

You have drawn attention in this circular to the fact that it was not necessary to enforce suddenly those of the decisions of the Congress which refer to details of less importance, and as some other arrangements are already made, we may be very brief in this respect, the more so as the Permanent Committee in the meeting to be held at Utrecht in September will consider the various questions, at the request of this Conference.

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However, to commence with this year, measures have been taken for the publication of a *tri-monthly Bulletin* (Bulletin de décade), in which it is intended to give, with the greatest possible care, the meteorological conditions observed thrice daily at about 20 stations, distributed over the whole surface of Italy, and to send it to the Central Meteorological Institutions of the countries interested in the study of great atmospheric disturbances.

The plan of this bulletin will be gradually improved, and will receive its definitive form after the deliberations of the Permanent Committee on this subject.

As to the *monthly publication* in which the results of the 60 other stations are combined, we shall continue to follow the form adopted for the eight last years, because any considerable changes in such a series of data which offer a special interest for the study of local climates, as well as for their application to the agriculture and hygiene of the different provinces of Italy, cannot be introduced before the end of 10 years without great inconvenience.

Thus the new tri-monthly bulletin will refer more particularly to that general portion of the Science which may be called International Meteorology, whilst the monthly bulletin will continue to devote itself to local Meteorology or Climatology.

The Italian Observatories already use the centigrade scale for temperature, and the metric scale for atmospheric pressure. The meteorological day commences at midnight, and the figure 10 denotes an entirely overcast sky, and O a clear sky, as you recommend in your Circular. As to the calculation of the mean temperature, this is already done at several stations for every five days.

In future we shall endeavour to introduce into the local meteorology the greatest possible uniformity with foreign meteorological publications.

At the same time this Ministry is disposed to co-operate with the other great Meteorological Institutions in extending more and more the net-work of the International Meteorological Stations, and to inaugurate the new series of Synchronous Observations over the whole surface of the globe.

It is for this reason that, with our knowledge, Professor Cantoni has acceded to the invitation of General Myer by making at the Observatory of the Royal University of Pavia, a series of observations simultaneously with those made by the United States under the direction of that General, and by having observations made at the same time, and as nearly as possible in a similar manner, at other stations suitably distributed through Italy.

We expect therefore that the Permanent Committee will inform us in what manner Italy can assist in the work done by the other great nations for the advancement of general Meteorology.

You inquire in your Circular whether we have in Italy central or principal meteorological observatories, to which it would be suitable to send the publications of the Permanent Committee. At present there are none, although we intend to establish a real Central Observatory or Institution. We can tell you, however, that all the meteorological stations of Italy have their centre at the Statistical Branch of this Ministry, as is shown by the publication of the respective results of their observations, which has been done for several years in the Bulletin entitled "Meteorologia Italiana." Further, these stations have been divided into three classes, according to the degree of their relative importance. The first comprises the University observatories, or those annexed to an astronomical observatory, such as those of Turin, Pavia, Padua, Genoa, Modena, Florence, Rome, Naples, and Palermo. It would suffice, however, if you sent to this Ministry (Statistical and Meteorological Division) the copies which you should wish to be distributed to the principal Observatories.

G. T. Kingston, M.A., Magnetic Observatory, Toronto.

With reference to your circular, dated Utrecht, December 31st, asking me to send to the Permanent Committee for International Meteorology a report on the changes that have been carried out in Canada, in conformity with the decisions of the Vienna Congress, I regret that I have not seen an account of the transactions at Vienna, and am therefore unable to state whether it will be practicable or not to bring the Canadian system into perfect conformity with

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those decisions. I assure you, however, that I will gladly do what is possible to bring about such conformity.

Confining further remark to the contents of the circular.

At Toronto I employ thermometers, "à l'échelle arbitraire," by Fastri, of Paris, barometer by Newman, anemometer by Robinson. During this summer I propose to introduce photographic self-recording instruments, such as are in use at Kew.

At other stations under my control, the thermometers are mostly by the best London makers, and in Fahrenheit's scale. They have been compared at Kew and at Toronto. The barometers are nearly all by Adie, of London, or by Green, of New York. The anemometers are furnished with Robinson's hemispheres, the distance passed over by the wind being recorded by dials.

With respect to the comparative advantages of monthly and annual publications, if the question lies between monthly publications only, and annual publications only, I would give the preference to annual publications, but I think it would be still better that reports be published *every month*, in such a form as would admit of their being collected afterwards in an annual volume, accompanied by a *resumé* and discussion of the work of the year.

I am willing to comply with the recommendations in the Circular, except that which relates to the use of the centigrade and metric scales. It would be impossible to abolish the use of our present instruments, but I am willing to print the mean values in the centigrade and metric scales.

As regards the establishment of observatories in remote places, I have to inform you that in addition to the stations in older settlements, there are stations at Fort Garry, and in British Columbia, and I hope to establish others during the coming summer near the Arctic Circle on the Mackenzie River.

Fradesso da Silveira, Observatory of the Infant D. Luiz, Lisbon.

In reply to your circular of the 31st December 1873, I have the honour of communicating to you firstly, the details relative to our instruments.

The barometers for the observations both of our observatory and those of the meteorological stations are graduated to the metric scale; they are on the principle adopted by the Meteorological Committee of the British Association, and are made by Adie, of London.

All the barometers are compared with the standard barometer of this observatory, which is on the syphon principle, of 18 millimetres interior diameter, reading to 0·01 millimetre, and of French make, by Lerebours and Secretan, of Paris.

The Standard Thermometer was a present from the Kew Committee of the British Association, it has a centesimal scale graduated to $\frac{1}{5}$ degree, the zero point has been checked at different times and has never shown any displacement.

The psychrometers at the observatory and at the meteorological stations have the centigrade scale, the make is English, by Negretti and Zambra, of London. They are compared with the standard thermometer of the Observatory.

The anemograph of the observatory and those of the meteorological stations are on Robinson's principle with metric scales.

From the 1st January 1874 we follow both in the observations of the observatory and those of the meteorological stations, the instructions of the Vienna Congress with respect to the following points:

1°. State of the sky } 0 = clear sky. 10 — overcast.

2°. The direction of wind, *W* instead of O.

3°. The day commences at midnight and the hours are indicated thus, 0—12=a.m., and 0—12=p.m.

4°. The meteorological year commences on the 1st January.

5°. We calculate the means of temperature for every five days.

We have not adopted the other measures, which are no doubt of greater import, because we have not yet received the translation of the resolutions of the Vienna Congress.

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Capt. N. Hoffmeyer, Danish Meteorological Institute, Copenhagen.

Agreeably to the wish expressed in your circular of the 31st Decr. 1873, I have the honour to inform you that the Meteorological Institute has entirely conformed to the decisions taken by the International Congress of Vienna, which in fact was not very difficult, since fortunately we have had only very few changes to make to arrive at this result. I should, however, remark that the very distant Danish stations in Iceland and Greenland can only be warned of these changes later.

As to the instruments employed at the Danish stations of the second order, I will remark:—

1°. That the barometers, graduated in millimetres, are all mercurial, in Denmark, on the principal of M. Kappeller of Vienna; in Iceland and Greenland either of Fortin's or Kew pattern, by Mr. Adie, of London.

2°. That the thermometers are centigrade, graduated to $\frac{1}{5}$th degree, and fitted in double louvred wooden screens.

3°. That the minimum thermometers are on Rutherford's principle, and the maximum on Phillips' principle.

4°. That the psychrometer is employed for determining the humidity of the air.

5°. That the rain-gauges have areas of $\frac{1}{10}$th square metre, and are fixed six feet above the ground.

6°. That the inspection of the stations in Denmark is made once in each year by the director or sub-director of the Institute, and that all the instruments are then checked.

7°. That the stations in the Färoe Islands, and in Iceland, are inspected each year by the captains of the vessels of war which visit those parts.

8°. That the stations in Greenland can only be inspected occasionally.

For the publication of the observations we are waiting for the appearance of an international form.

The Danish Institute has succeeded in establishing a system of meteorological stations in the North Atlantic, which may become of considerable importance. At the present moment there are six complete stations of the second order, viz., 2 in Greenland, 3 in Iceland, and 1 in the Färoe Islands. Several other stations only require to be furnished with barometers to be complete also. One of the latter (at Upernivik in Greenland) is, as far as I know, the most northern station in the world (Lat. 72° 48′ N.). We are going to try to send one of Adie's barometers to this distant place.

A. Aguilar, Astronomical Observatory, Madrid.

You are aware already that the Observatory of Madrid is quite ready to comply with the decisions taken at the Congress of Vienna. That is all the more easy for us, as the changes which we have to introduce into our system of observations are very trifling, having adopted long ago the metric scale for the barometer, and the centigrade thermometer. Moreover, the number of observations which we make is far greater than that proposed.

Meteorology comprises two very distinct questions, one which interests science in general, and for the advancement of which each country ought to contribute a certain number of observations, so as to embrace the largest possible part of the globe; the other, which is not less interesting by reason of its useful applications, refers to the climatology of each country, and to carry out this study we must increase the number of observations as much as possible, to bring to light even the smallest local influences. These observations may be the more complete owing to the fact that they embrace but a small extent of the globe.

It is to me self-evident that the former kind of work should not take account of all the observations made in each country, for the accumulation of observations which would be thereby produced would be more hurtful than useful, without reckoning the excessive labour which would be imposed upon the person charged with arranging and suitably discussing these observations.

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We must then separate the observations destined for the object which is proposed to be effected by the International Committee (as representing the wishes expressed at the Congress of Vienna), from the observations which we may wish to make in each country for a very different object. This separation will remove many difficulties, for each physicist has his peculiar manner of viewing the meteorological data, and a complete freedom of action must be left to each. If it is wished to give him a model, to which he must subject himself, great risk is run of increasing the difficulties of arriving at a mutual agreement, for which we ought to all strive. The model can only be proposed for the observatories which enter into the system of International Meteorology.

This being established, it is desirable that the Permanent Committee should express its opinion on the number of observatories which each country should contribute for the general study of the movements of the atmosphere. Thus, for example, of the 30 observatories which exist in the Iberian peninsula, how many should contribute to the international publication, which I think indispensable? As to the choice of these observatories, this should of course be left to the central observatory of each country, which is able to take account of small details which would doubtless escape the Permanent Committee for want of the necessary information.

Now, in reply to the principal decisions of the Congress I should inform you—

1°. That our instruments are of very careful construction; that the barometers are all mercurial, on Fortin's principle, as we have completely eliminated the aneroids.

2°. That the thermometers are generally by Casella, of London, all centigrade, and mostly compared with the standards at the Central Observatory of Madrid.

3°. Whether the international publication be monthly or yearly is a question to be decided by the Permanent Committee, or, better still, by the person charged with the collection of the data for the purpose of submitting them to scientific discussion. For our own part this is entirely a matter of indifference.

4°. In our Spanish alphabet the letter W is very little used, but however we shall adopt it to indicate the direction of wind from West.

5°. We have always indicated clear sky by O, and overcast by 10; we shall continue the same course.

6°. We have always begun the meteorological year on the 1st December, and the day at midnight, but, agreeably to the wish of the Congress, we shall commence the year on the 1st January.

7°. The calculation of mean temperatures for periods of five days gives an increase of work which is not compensated by the advantage derived therefrom. However, I should propose to the Spanish stations which co-operate in the international work to calculate the 5-day means.

In addition to the observations made in the Peninsula, and which are dependent on the Observatory of Madrid, I shall take steps to procure those also of the Canary Islands in the Atlantic Ocean; those of Porto Rico and Havana in the Antilles; and those of the Philippines, which would be the continuation of those promised by Mr. Hart on the coast of China.

A. Buchan, Secretary, Scottish Meteorological Society, Edinburgh.

I now forward to you, in answer to your circular of 31st December 1873, the opinion of our Council on the Resolutions come to by the Vienna Congress on the 29 propositions brought before them.

The numbers refer to the questions of the Vienna Programme.

1. Fortin's Barometer, Board of Trade, and Barometers with a float are used at Society's Stations. 1.

2. Stevenson's Box, painted white inside and outside, screwed to four white posts fixed in the ground; the posts of such a length that when the thermometers are hung in position the bulbs of the Minimum Thermometer and of the Dry and Wet Bulb Thermometer are exactly 4 feet above the ground. The Maximum Thermometer is hung immediately above the Minimum Thermo- 2.

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meter. The Thermometer Box is placed over a plot of grass and in a free open place, to which the sun's rays have free access during as much of the day as possible.

3. 3. Phillip's Maximum, Negretti and Zambra's Maximum, and Rutherford's Minimum, are used by the Society.

4. 4. The instruments hitherto used are Maximum and Minimum Thermometers, with blackened bulbs projecting beyond the scale; in a few cases thermometers in glass jackets.

5. 5. Observations of Earth Temperatures have been made at many of the Society's stations for about 18 years with thermometers permanently fixed in the ground at depths of 3, 12, and 22 inches. The Council intend to adhere to the method of using fixed thermometers at 12 inches and 22 inches, as well as at 3 inches, as being, in their opinion, preferable to Lamont's method for these depths, which was recommended by the Vienna Congress.

The 3-inch depth is meteorologically the most important; the temperature at even less depths is also very important.

6. 6. The Dry and Wet Bulb Hygrometer is exclusively used at the stations, as being the best means suited for general adoption.

For the most exact discussion of the results of the Dry and Wet Bulb Observations, the Council are of opinion that a revision of the Tables is necessary. The defects of the instrument are its difficult manipulation in winter, when there is frost, and during sudden changes of temperature, in which case the Wet Bulb is not sufficiently sensitive.

7. 7. The practice of the Society agrees with the decisions of the Congress, except that hitherto all winds have been included in constructing Wind-Roses.

8. 8. The scale used by the Society's Observers is 0 to 6, or half that of Beaufort, and an effort has been constantly made to bring the scale 0–6 into agreement with that of (0–12) Beaufort.

9. 9. Wild's Anemometer is not known in Scotland. Two new ones have just been proposed by members of the Society—the one by Mr. T. Stevenson, Honorary Secretary, and the other by Mr. Robert Ballingall, Observer for the Society at Eallabus—which will be described in an early number of the Society's Journal. The units used by the Society have been miles per hour, and lbs. per square foot.

10. 10. The gauges employed by the Society are circular ones of 3, 5, 8, and 12 inches diameter, and since it has been experimentally proved by extensive observations and experiments that gauges from 3 to 24 inches diameter, inclusive, give returns which do not differ more from each other than two per cent., the Council will continue to use the gauges referred to above, gauges of 14 inches diameter being unnecessarily large.

The gauges at Society's Stations are nearly all at heights varying from one foot above the ground to the surface. The Council are of opinion that a height varying from 3 to 4½ feet is objectionable on account of the greater strength of the wind at 3 or 4 feet as compared with 1 foot and less, and consequently at the greater height the eddies in the funnel are stronger, and the whole air currents round the gauge more disturbed. Thus the rainfall can be more correctly observed with gauges whose rims are a foot or less above the ground.

The gauge is read at 9 a.m., and the amount is put down to the previous day, and many of the Observers estimate the duration of the fall in hours.

11. 11. Rain and snow are grouped together in the published tables, but are distinguished in the "Remarks" column.

12. 12. "Graupel" is not known in this country, except as one of the forms of hail, and is called hail. The different kinds of hail are often noted in the schedules.

13. 13. The decision of the Congress agrees with our practice.

14. 14. Four observers note the evaporation, but the subject is not in a satisfactory state. Several experiments have been made, but nothing is decided.

15*a*. 15*a*. Our practice has always been in accordance with the decision of the Congress.

15*b*. *b*. Decision of Congress will be carried out where practicable.

16. 16. Ozone has been observed twice a day for 18 years at many of the Stations. On this subject, and the difficulties attending its observations, the opinions of the council agree with the decision of the Congress.

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17. The units used by the society are English inches and Fahrenheit's scale. There is no probability of these being changed for metric and centigrade scales. All results hitherto published by the Society have been in these measures. 17.

18. From the commencement the hours of observation have been 9 a.m. and 9 p.m., and Maximum and Minimum Thermometers have been in use at the stations. 18.

19. The decision of Congress agrees with Society's practice. 19.

20. Ditto, ditto. 20.

21. The opinions of the Council on this question have been sent to the Committee (Buys Ballot, Neumayer, and Scott). 21.

22. The Society has observed the temperature of the sea at several stations during the past 18 years, and they have recently extended their observations to the Irish and English coasts, at which, as well as at some points on the Scottish coast, it is proposed to have daily observations made with Maximum and Minimum Thermometers, *continuously immersed*. At the same places other observations will also be made. The Society has also recently taken up the question of the influence of the sea on climate, and its extension inland, particularly its effect on the isothermals near the coast. The Society has collected a large amount of statistics referring to Ocean Meteorology. A form is enclosed on which the observations are entered. Part only of this information has been discussed. 22.

23. There should be one or more Central Institutions in each country, either dependent or independent of each other, according to the requirements of each country, for the direction, collection, and publication of the meteorological observations. Thus, the Scottish Meteorological Society is separate from and independent of the Meteorological Office of London. 23.

24*a*. The instruments used at the Society's Stations are first verified with the Society's standard, and as regards the Inspection of stations I have to refer to the paper on the subject in the *Bericht über die Verhandlungen des internationalen Meteorol. Cong. Wiens*. 24*a*.

b. The Society has always had instructions for taking and calculating meteorological observations, which are now in the course of being revised; a copy will be forwarded when ready. 24*b*.

25. By an exchange of their standard instruments. 25.

26. The Council are most desirous of being in a position to publish the daily observations of a selected number of their stations for general distribution. For this purpose they have several times asked assistance from H.M. Government; hitherto, however, without success. 26.

27. By the establishment of such an agency as the Smithsonian Institution. 27.

28. The carrying out the decisions of the Congress may be left to the care of the Permanent Committee. 28.

29. With reference to Plantamour's proposal respecting the establishing of an International Central Institute, the council are not in a position to express an opinion. 29.

Professor H. Mohn, Meteorological Institute, Christiania.

I have the honour and pleasure to state that our National Assembly has voted to the Meteorological Institute a special grant of 1,500 sp. (350*l*.), in order to enable the Institute to carry out the decisions of the Meteorological Congress of Vienna, especially with regard to instruments. In this sum is also included the cost of the "Bulletin du Nord."

The decisions of the Congress have made scarcely any changes necessary in our system of observations. The changes which I shall introduce on account of the Congress refer especially to new instruments and to the method of calculation and publication. As no final decisions can yet be made in these matters, I have nothing to report thereon.

R. H. Scott, F.R.S., Meteorological Office, London.

I beg to enclose my reply to your circular of the 31st December last, from which you will see that, generally speaking, the methods followed by the

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system under this Office are in accordance with the recommendations of the Congress.

The numbers* refer to the programme of the proceedings of the Meteorological Congress at Vienna in 1872.

2. The experiments at the Royal Gardens, Kew, as to the effect of height on temperature are still in progress. No definite conclusion as to thermometer screens has yet been adopted.

4. Radiation is not as yet regularly observed at all the stations in the British Isles.

5. The subject of Earth Temperature has not yet been undertaken by us on any large scale.

8. The following scale has been proposed by me in a paper recently read before the Meteorological Society for the conversion of velocities in miles per hour or in metres per second to the figures of Beaufort scale. It has been based on direct experiments conducted at Holyhead and Yarmouth with anemographs of the pattern described in the Report of the Meteorological Committee for 1869.

Figures. Beaufort Scale.	Approximate Miles per Hour.	Velocity. Metres per Second.
0. Calm	3	1·5
1. Light air	8	3·5
2. Light breeze	13	6
3. Gentle ,,	18	8
4. Moderate ,,	23	10
5. Fresh ,,	28	12·5
6. Strong ,,	34	15
7. Moderate gale	40	18
8. Fresh ,,	48	21
9. Strong ,,	56	25
10. Whole gale	65	29
11. Storm	75	33·5
12. Hurricane	90	40

10. The experience in this country is decidedly against the necessity of employing a gauge with a collector of 14 ins. diameter (0·1 square metre area), The Meteorological Office will continue to employ gauges of 8 ins. diameter which have been proved to work admirably.

17. I cannot hold out hopes of the adoption of the metric and centigrade system in the United Kingdom and its colonies.

The Meteorological Office will continue to give important results of discussions in these measures, in addition to printing them in their original measures.

18. I can add nothing to the remarks made by me at the Congress. Our observatories record continuous observations. The great majority of British volunteer observers have expressed their preference for observations at 9 a.m. and 9 p.m., with maximum and minimum.

21. The conditions of the British Isles are so exceptional as regards Weather Telegraphy that I can only undertake to carry out the recommendations of the Congress whenever *possible*.

The Office has already adopted one measure recommended by the Congress, the employment of a signal to indicate the direction of the wind in an apprehended storm. Preparations for the daily or occasional issue of "probabilities" are in progress.

Dr. C. Bruhns, Observatory, Leipzig.

Generally speaking, the observations here were already so organized that the Vienna decisions could be easily carried out.

* A selection only of the replies is printed here; in all the other points the practice of the Meteorological Office agrees with the Resolutions of the Vienna Congress.—*R. H. Scott.*

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First, as regards the hours of observation, they are, like those at most of the North German stations, made at 6 a.m., 2 p.m., and 10 p.m. The atmospheric pressure has been given in millimetres since the year 1871, the temperature in centigrade degrees, the relative humidity in percentages, the amount of cloud in the scale of 0 – 10, 0 = clear sky, the amount of precipitation in millimetres.

I have made arrangements for the wind directions to be given in the English notations, and they will so appear in the publications from the year 1876, with the beginning of the new lustrum. It was not possible for the year 1874, as the first months were already in the press before the observers could be informed of the decisions of the Congress. For the wind-forces, also, the figures will also appear according to the desired notation, from the year 1876, and for the hydrometeors the symbols are in use, and the form has been given to the observers.

The rain and snow gauges have hitherto been fixed at a height of 2·6 metres, and have square receivers, as in the case of the North German stations, but I have taken care that from the year 1876 all stands, wherever possible, shall be reduced to a height of 1·5 metre, and that, instead of the square receivers, circular ones shall be adjusted.

With respect to the Publications of the first order, I shall adopt the form to be agreed upon.

Professor H. Wild, Central Physical Observatory, St. Petersburg.

The yearly Reports of the Central Physical Observatory for the years 1869–72, together with the Annals of the Central Physical Observatory and the Instructions for our meteorological stations, printed in Vols. I. and II. of the "Repertorium der Meteorologie," give such complete information as to the state of meteorological investigations in Russia that I can dispense with giving further particulars here.

It will be seen, from the publications of the Central Physical Observatory, that in Russia, the decisions taken at the Meteorological Congress are to be considered as already in a great measure carried out by the existing arrangements.

With respect to the remaining decisions of the Congress, the Imperial Academy of Sciences has, on my report, appointed a special Commission for the consideration of suitable measures for carrying it into effect, and, on its recommendation, has taken the following steps:—

1. The Academy has proposed to the Russian Government the recognition of the continuation of Meteorological Congresses and of the Permanent Committee. This recognition has since been accorded, and the Government has confirmed me as a member of the committee, and voted a yearly grant of 50 rubles 32*l.* for the expenses connected with the latter.

2. The Academy has proposed to the Marine Ministry the establishment of a Central Station for maritime meteorology and for storm-warnings, and a committee has already been appointed, consisting of members of the Academy and officers of the Navy, for the development of the project in question, which has already begun its deliberations.

3. The Academy has commissioned me to write new Instructions for the meteorological stations, introducing in them the modifications required by the decisions of the Congress. These modifications refer to wind-direction (16 directions instead of 8 as heretofore), notation of wind velocity in metres per second instead of the scale 0 – 10, new symbols for hydrometeors and their degree of intensity, calculation of five-day means for some places. On account of several hindrances, I have not yet finished these Instructions.

4. From the 1st January 1874, the simultaneous observations at 7.35 a.m. Washington time, as recommended by the Congress, have been taken at 25 stations of the Russian empire, and have been also partially published. In these observations we have used the new symbols for hydrometeors, and the notation of wind velocity in metres per second.

5. For the extension of our network of stations, five new meteorological stations in European Russia, seven stations in West Siberia, and six in East

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Siberia, China, and Japan, have been established during the first half of this year.

Dr. C. JELINEK, I.R., Central Institute for Meteorology, &c. Vienna.

1. The metric system has been used since the year 1871 in the Publications issued by the Central Institute of Vienna.
2. The exchange of old for new instruments graduated to the metric measure is almost completely carried out at the stations of the Austrian Meteorological system.
3. We have not yet been able to introduce Wild's new wind-gauge recommended by the Vienna Congress.
4. From 1st January 1874, the notation of the winds, agreeably to the decisions of the Congress, is that used in England.
5. The distribution of the winds is not given in percentages, but according to the number of actual observations, including the calms.
6. The wind velocity is given in metres per second at all stations provided with dial-instruments or registering anemometers; at the other stations the scale 0–10 must be retained for the present.
7. The maximum and minimum Thermometers are read in the evening.
8. The symbols recommended by the Vienna Congress for hydrometeors have been introduced.
9. Seven stations in Austria (exclusive of five in Hungary) assist in the synchronous observations collected by Gen. A. J. Myer.
10. From the year 1874 original observations from about 12 stations taken at three hours daily, will be published in the "Jahrbuch" of the Central Institute; the publication of the Telegraphic Weather Reports (for which moreover an autographic daily bulletin exists) is discontinued in the "Jahrbuch."
11. From the 1st July 1873 we have begun to publish an autographic daily weather bulletin, which is sent to the various central establishments, and also to private meteorologists, and stations in Austria.
12. From 1 January 1874 we have begun to introduce the reduction of Barometer readings to the sea level in the Daily Weather Bulletin instead of the barometrical deviations.

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APPENDIX B.

SIR, Utrecht, September 9, 1874.

I HAVE the honour to submit to you herewith a copy of the Protocols of a Maritime Conference, held in London from August 31 to September 2, in accordance with Resolution VII. of the Permanent Committee at the meeting on September 16, 1873.

A majority of the members of the Sub-Committee named by that resolution having decided that it was advisable that the Conference should be unofficial, that character was given to it in the letter of invitation,* of which I enclose a copy, as well as of the programme adopted for discussion.

The Conference was attended by 25 gentlemen, whose names are in the Protocol, belonging to most of the maritime countries of Europe. Sweden and Turkey were not represented and Greece was not invited.

The United States sent no representative. India and China were both represented. The meetings were held, by invitation of the Meteorological Committee, at their Office.

It is intended to publish a report of the Conference in English, but none of the resolutions have as yet been made public.

I have the honour to be, sir,
Your most obedient servant,
ROBERT H. SCOTT,
Secretary to the Sub-Committee.

Prof. Buys Ballot,
President Permanent Committee
of the Vienna Congress.

CONFERENCE ON MARITIME METEOROLOGY.

Programme.

A general wish has of late been expressed that the measures for the prosecution of Maritime Meteorology proposed at the International Conference at Brussels in 1853 should be reconsidered, now that the experience of more than 20 years of the operation of these measures has enabled meteorologists to form opinions as to their utility.

At the Meteorological Conference at Leipzig in 1872, and again at the International Congress at Vienna in 1873, preliminary discussions took place on the subject of the more successful prosecution of Ocean Meteorology. Certain resolutions were adopted at Leipzig and confirmed at Vienna, and accordingly it seems proper to embody them in the present programme. They run as follows :—

" 1st. Thorough uniformity in methods and instruments should be aimed at in the same measure as for observations on shore. This will be most satisfactorily attained by the chiefs of the Central Institutes, the establishment of which in all countries, in which they do not already exist, and in which the maritime interests demand them, must be declared as absolutely necessary, entering into relations with each other and agreeing on the separate details, the construction of the instruments, the hours of observation, the journal, &c.

" 2nd. Unity of measures and scales is desirable, and to this end the introduction of millimètres for the Barometer and the centigrade scale for the Thermometer should be aimed at. While, however, the comparison of standard instruments of the individual central stations must be insisted on, the uniformity of scales is at present only declared as desirable.

* The letter of invitation is not reprinted here.

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"3rd. The Committee would urge the importance of the co-operation of the navies, inasmuch as by their assistance, and by the opportunities afforded thereby of completeness in certain observations, the determination of factors and constants is rendered possible, which can be used with advantage for the reduction of certain results derived from the general system of observations.

"4th. With reference to the utilisation of the results, the Committee would urge similarly the importance of uniformity in the methods employed. In close relation therewith was the carrying out of the division of labour of the central stations of the individual states. This principle must be recognized as of the greatest importance for the further development of Marine Meteorology. The repetition of work over definite regions, with reference to the area to be investigated, must be declared as indefensible in the interests of this development."

It was further resolved—"That the convening of a Maritime Meteorological Conference is desirable."

While accepting the above resolutions as a general expression of the principles which should form the basis of an agreement as to future operations in the field of Ocean Meteorology, the Sub-committee to whom the negotiations preparatory to the assembling of a Conference have been entrusted, consider that it is advisable to enter more minutely into the details, and have accordingly agreed on the following series of questions:—

In the case of a nation which sent any representative to the Brussels Conference in 1853, a circular should be addressed to the chief of the Office for Maritime Meteorology, if such exist, or to the chief of the meteorological organisation of the country, requesting them to state—

1. To what extent the resolutions adopted at Brussels have been carried out in his country?
2. What have been the grounds for departure from them, if such departure has taken place?

And to send his reply to the Secretary to the Sub-Committee, Mr. Robert H. Scott, 116, Victoria Street, London, S.W., before the 1st of June next, in order to allow ample time to draw up a report on the replies for consideration at the Conference.

It seems advisable that, as above stated, the action taken at Vienna should be carefully reconsidered under several heads which will now be recapitulated

The following are the questions proposed in the programme with the several resolutions adopted by the Conference on each.

Any gentleman into whose hands this programme may come, and who is himself not likely to attend the Conference, is requested to forward any remarks he may wish to make on any of the subjects mentioned herein to Mr. Scott, at the above address, before the 1st of July 1874.

Resolutions.

Resolved—"That there should be but one form of Meteorological Log for the Navies and Merchant Services, and that those who cannot fill the log should keep part of it."

Questions.	*Resolutions.*
I.—Observations.	
Columns 1 to 6.*—*Date and Position of the Observations.*	
Is it your opinion that a fresh column should be added headed "Course and distance by the log in "every watch of four hours?"	That an additional column should be given in the log for "Course and distance." That the course should be expressed in degrees, and not in points. That the question of hours, 4-hourly periods, as proposed by Captain Toynbee, and in general use by Dutch and German captains since 1865, should be adopted.

* The numbers of the columns refer to the Brussels Abstract Log.

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Columns 7 and 8.—*Currents.*

That observations on the "direction and rate" of currents be transferred to the column for Remarks.

Column 9.—*Magnetic Variation.*

Is it desirable to give an additional column for the "Direction of ship's head"?

That an additional column be given in the log for the direction of the ship's head, and the amount of heel to port or starboard.

That the Total Compass-error and not Variation only be given.

That the Conference expresses its opinion that the lettering on the English compass should be adopted by all nations for meteorological purposes.

Columns 10 and 11.—*Wind Direction and Force.*

Is it possible to employ an anemometer at sea, so as to give trustworthy results?

That a decided answer to this question cannot at present be given, but it is desirable that various anemometers should be tested by special ships, and that a special form of four extra columns should be prepared for the purpose of recording such observations.

Can the use of the Beaufort scale be made universal?

That the use of the Beaufort scale should be continued, with the addition of the amount of sail which Beaufort's ship would have carried had she been rigged with double topsails. Also that the direction and force of the wind should be recorded at the *time* of observation, and not estimated for a certain number of previous hours. Also, that they should be recorded every two hours.

Columns 12 and 13.—*Barometer.*

To what degree of minuteness is it necesssary to observe this instrument?

To one-hundredth of an inch at sea, or its equivalent in the metric scale.

Columns 14 and 15.—*Thermometers, Dry Bulb and Wet Bulb.*

Should these observations be required from all ships?

That wet and dry bulb observations are desirable, and should be obtained whenever possible.

Column 16.—*Forms and Direction of Clouds.*

Is this column sufficient, or should any notice be taken of more than one stratum of clouds?

That the upper and lower clouds should be recorded in separate columns, and that the direction from which *upper* clouds come should be recorded when possible.

Column 17.—*Proportion of Sky Clear.*

Is it not advisable to substitute for this heading "Proportion of sky clouded"?

That it is preferable to give the proportion of sky clouded instead of the entry "proportion of sky clear," as recommended by the Brussels Conference.

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Column 18.—*Hours of Rain, Fog, Snow, &c.*

Is it desirable to retain this heading, or to substitute for it and No. 23 a column headed "Weather by Beaufort Notation"?	That it is desirable to retain this heading, but that the use of Beaufort's Notation may be continued by those accustomed to it.

Column 19.—*State of the Sea.*

Should this be given according to a numerical scale?	That a numerical scale (0—9) be adopted, and that an extra column should be given to the observation. The direction of the sea, swell, or the different swells, to be given in the original column.

Columns 20 to 22.—*Temperature of Sea Surface, Specific Gravity, Temperature at Depths.*

Is it desirable to retain these columns, or can the observations when taken be inserted in the column for "Remarks"?	That the first two columns should be retained. That sea temperatures at depths should not be required from all ships, and should be recorded in the "Remarks."

Column 23.—*Weather.*

Vide the resolution on Col. 18.

Column 24.—*Remarks.*

That the "Remarks" as asked for by the Brussels Conference should be adopted, with the exception of the observations of Temperature with coloured bulbs at sea.

II. Instruments.

What patterns of instruments should be employed for any observations which may require them.	That the question of the precise pattern of instruments is not of very great importance, so long as they satisfy the tests applied at the several central institutions, and are compared with standard instruments; but it is recommended that they shall be of a pattern as easy as possible for reading.
Is there any reasonable possibility of introducing the metric and centigrade systems for general use at sea?	The recommendation respecting the use of the metric and centigrade systems as expressed at the Vienna Congress was approved, and it was recommended that a table of conversion should be entered in each log to enable captains to compare barometers which have different scales.

III.—Instructions.

Is it possible to devise a general form of Instructions to ensure uniformity in regard of methods of observation and registration?	That the Instructions should be suited to the log now proposed by the Conference, but modified to meet the various requirements of different nations.

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The Conference requested that Capt. Toynbee's proposed form of log should be printed, and the English "Instructions" printed for circulation amongst its members.

IV.—Observers.

What control should be exercised over the Observers as to their instruments and registers?	That it is necessary that all instruments used should be compared with standard instruments, either at the central or the filial institutions (if such exist), before and after the voyage; and that the corrections and date, &c., of the comparison should be entered in the log.
Is it desirable that all instruments employed should be the property of the central establishment, and *lent* to the observers?	That it is desirable that the instruments should be the property of the central office. That it is necessary that a careful examination should be made into the quality of the observations recorded, and that the attention of the observers should be specially directed to any errors which may have been detected.

V.—Co-operation of the Royal Navy.

To what extent can ships of war assist in forwarding the ends of meteorological inquiry?	The Royal Navy can furnish more complete observations than are possible on board merchant ships, as, *e.g.*:— Deep-sea soundings and temperatures. Observations in unfrequented parts of the sea. Special experiments. It is most desirable that the duty of observing should be entrusted to some responsible officer. It is therefore resolved that the authorities of the navies shall be requested to continue to give such assistance to the prosecution of meteorological science as circumstances shall permit.

A report was handed in which had been drawn up by a number of the members who were in the naval services of some of the countries represented, and it was decided that the following resolutions which it contained should be adopted in lieu of those given above:—

1. "It is very important that the organisation of meteorological inquiry as regards the navies of all countries should be arranged in accordance with the principles and stipulations laid down by the Conference for Marine Meteorology generally; and it is further important that the results of all observations made on board ships of war in any country should be rendered accessible for discussion by the central station for maritime meteorology in that country without prejudice to any subsequent publication by their respective naval authorities."

2. "The Conference, while admitting that the introduction of measures calculated to improve the condition of meteorological inquiries in the navy must be left to the authorities of the respective navies, is nevertheless of opinion that all care should be taken to secure uniformity as to mode of observation, and

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especially to provide for the comparison of all instruments used, with the respective standard instruments of the central institutes."

3. "The Conference considers it to be its duty to request that those entrusted with the management of scientific affairs on board men of war will lend their strenuous support in securing from the naval authorities in each country such regulations as will place meteorological inquiry on board such ships in as favourable a position as may be deemed consistent with the execution of the ordinary duties of the service, and will also induce the commanders to render to such inquiries all the assistance and furtherance in their power. The Conference, knowing that such regulations must be framed according to the requirements of each country, expresses, nevertheless, its opinion that inasmuch as meteorological observations require considerable experience, they should be entrusted to experienced officers on board suitable vessels."

4. "Although the Conference is of opinion that, as far as the general scope of meteorological inquiry goes, the same form of register should be supplied to merchant ships as to men of war, it declares it will be most desirable that, besides the regular observations, a more extended scale for scientific inquiry should be adopted on board ships of war, as in such cases there is a larger number of suitable officers, as well as more means for carrying on the service. As examples of observations which are of importance for the development of maritime meteorology, over and above the regulations embodied in the scientific instructions given to naval expeditions for the special purpose of the advancement of science, the following suggestions may be enumerated:—

(*a.*) "Possibility of carrying out accurate observations on the velocity of the wind by anemometers at sea.

(*b.*) "Possibility of employing rain gauges satisfactorily at sea.

(*c.*) "Observations with Regnault's and other hygrometers, and experiments on the best mode of observing wet and dry thermometers, and the best position to place them in on board ship.

(*d.*) "Currents at the surface and at depths to be observed with great minuteness, with the special object of defining their limits.

(*e.*) "The comparison of various instruments, among which are expressly mentioned that of aneroids with mercurial barometers. It is further deemed very desirable that frequent comparisons should be instituted between the instruments used at sea and meteorological stations on shore in various countries.

(*f.*) "Deep sea soundings and temperatures, with specimens of water.

(*g.*) "The collecting of information on ocean meteorology at outlying stations.

(*h.*) "The furnishing of synchronous observations at 0h. 43m. G.M.T., in accordance with the suggestion and request of the United States Signal Office."

VI. Discussion.

Can general suggestions be thrown out as to the most profitable mode of discussing the observations?

That it is desirable that every institution should publish the observations and results in such a manner that every foreign institute can incorporate them with its own observations and results in the easiest way possible; that is, by preserving the number of observations, together with any means derived from them, for single square degrees.

That it is further desirable that, whatever charts be published, the results for single square degrees should be published in a tabular form.

That it seems desirable for the use of the sailor that each chart should have reference to only one element, or, at least, only to elements closely related to each other

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VII.—Subjects of Inquiry.

To what extent can a division of labour, as regards subjects of inquiry, be carried out in a spirit of fairness to the collecting and discussing establishments respectively?

That the division of labour, as regards investigations, can only be carried out by mutual agreement, between the several institutions; and each institution should announce to other institutions what investigations it proposes to undertake.

It is very desirable that such division of labour should be effected.

VIII.—Sailing Directions.

In how far are purely practical investigations, such as the preparation of sailing directions, admissible for a scientific institution?

That the sailor wants the result of experience alone, and he must receive assurance that his observations have been turned to use. When these results of experience have been given, the theorist may point out the reason why certain routes are the best.

It was resolved, that Captain Toynbee's remarks on the programme should be printed in full, with extracts from the remarks of other gentlemen, should they contain important suggestions.

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APPENDIX C.

Report of M. Buys Ballot on the Velocity of the Wind in relation to its Pressure in Kilograms exerted on a Plate of 1/10 Square Metre.

MM. Jelinek, Scott, and myself were requested by the Meteorological Conference of Leipzig to examine the relations between the Force and the Velocity of the Wind, and to lay the results of that inquiry before the future Official Congress of Vienna.

As may be seen from the Report of the Proceedings of the Congress (published by Stanford, Charing Cross, London, 1874, p. 51) the experiments were not then completed.

I can scarcely say that my experiments are complete now, but, at any rate, they suffice to show the average relations between the force of the wind indicated by the pressure in kilograms on a square plate and the number of rotations of a Robinson's Anemometer, by Casella, the length of the arms of which is 174·5 mm., and the cups of which have a diameter of 77 mm.

It is this investigation which I have the honour to submit for your consideration.

I readily confess that it is only a very special side of the general question. My colleagues of the Sub-Committee will perhaps solve other special questions, and so we may arrive at the whole truth.

Before I proceed to give my results I beg leave to say a few words on the general question as well as on its more or less important branches.

The great desideratum is how to measure the real velocity (V), the real force (P), and the relation between these two quantities V and P, so that we may derive the one from the other, or if we prefer it, a result for the wind from the combination of the two.

We ought to verify, if necessary, to modify Smeaton's formula, having due regard to the investigations of Maxwell, Meyer, and others on the friction of gases; we ought to know what influence the constructions of the different anemometers now in use have on the result; for instance the area and form of the pressure plates, the diameter of velocity cups, &c.

Now we have different but all imperfect means of measuring both velocity and force. Force is (*a*) estimated only; (*b*) given by Beaufort's ship; (*c*) indicated by the Anemometer of Dr. Wild; (*d*) measured by the number of kilograms on a square metre or a part of it. Velocity is derived (*e*) from observations of small and light bodies carried by the wind; (*f*) from different rotatory Anemometers on Robinson's principle.

Each of these modes of measuring should be compared with the others, at least (*e*) or (*f*) with (*a*) (*b*) (*c*) or (*d*), since all these different modes of determining force and velocity are still in use. It is indeed very desirable to do so in order that the most imperfect modes may be rejected in future, that the others may be more generally introduced, and that all may be known in their relations to some standard measure.

Moreover it is especially desirable that Dr. Robinson's theory should be tested again, and that the experiments of comparing different Robinson's Anemometers, exposed to the same winds, should be repeated, since Mr. Stow has so very well shown that differences in the lengths of the arms and the diameters of the cups exert a marked influence not to be neglected.

Let us see what can be said on these different points:—

I. Estimated force (*a*) has been compared with (*e*) velocity of smoke by Professor Stamhart. He observed at Amsterdam the direction of the smoke

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and its apparent velocity from which he derived the real velocity with great accuracy. On the other hand, he compared the result with the estimated force of the wind at the same time at Swanenburg. It is true that the two places are 10 English miles apart, and this, he felt, gives ground for an objection. But he was not able to observe at Swanenburg, being prevented by his occupation. He gave, however, a comparative table as he thought it better on the whole to make such a comparison than to make none at all. He made it very skilfully, so that he expressed the force in two terms of the first and second degree of the velocity. At the time (more than 20 years ago) it could not be done better, for then there were no Anemometers in use. At the present time this comparison is of much less value, since even for such countries where, from want of Anemometers, the force is estimated separately for each observer such a relation ought to be computed.

II. A comparison between (*b*) and (*f*) would be of great importance, but meets with the same disadvantages and even with more, for not only are the topsails and reefs of a Beaufort ship a rough estimate and conducted differently according to the sailing more or less close to the wind, but also instead of real velocity (*e*) we have only imperfectly measured velocity which is often determined at a considerable distance from the sailing ship, or else at different heights and partially protected by hills, while the ship is at sea.

III. Equally difficult in a high degree, I think, would be a comparison of (*b*) and (*d*), and nevertheless I am sorry that I have not recommended this to be observed at Helder and Flushing where we have Osler's Anemometers. Not that I expect a very close connection or agreement between these two, but the opportunity for comparing being so very favourable at these places, it ought to be done for completeness' sake. There is, however, one reason why Beaufort's ship should more nearly agree with the pressure-meters than with the velocity scale, because by the pressure-meters the heavy gusts of wind are indicated, to which the sailors must attend, and in view of which he regulates the amount of sail carried, while the Velocity Anemometer, even though it is self-registering, cannot give those gusts of wind accurately enough.

I may be allowed to mention that I have several times applied to Lloyd's and "Veritas" to be informed at what place and time a ship was overtaken by a storm or hurricane, not so much to compare the indications of the anemometers on shore with the effects of such heavy gales, as to verify the storm warnings issued on that day or the day before. Our information regarding dangerous blasts of wind would considerably increase if we could get it not only from land observatories but also from the sea, and in the form which seems the best known. Though this only relates in a distant way to my subject, I beg a place for the remark on the ground of its importance. Neither would this information be so very difficult to obtain, since every ship which makes a claim from the insurance companies must necessarily relate when and where and how she was damaged.

IV. Since Dr. Wild has recommended his very simple Anemometers, which for their cheapness will perhaps be used more generally, their indication (*c*) ought to be equally well compared with other pressure-meters (*d*) and velocity meters (*f*). This last kind of instrument* must necessarily be compared with all other sorts of instruments and apparatus of the same kind, and in the first place with true velocity meters; the trials Dr. Wild mentioned at the Meeting of the Permanent Committee as having been done by M. Dohrandt.

We must know, moreover, the differences of results given by the different patterns of these instruments, and how the indication varies with different circumstances, different temperature and humidity, for it is not to be expected that the friction will be alike in dry and in wet weather, to which cause I think there is reason to ascribe a part of the irregularities which I observed. It is on

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* Robinson's Anemometers especially, since the Vienna Congress has decided that the wind should be registered by metres per second, to which physicists cannot object any more than to the measuring the force by kilograms per square metre, both methods of measurement relating to the absolute units of space and time.

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the whole very inconvenient too that we are never quite sure of the amount of this friction.

V. I had not one of Dr. Wild's Anemometers at my disposal, and so I chose to compare a Robinson's Anemometer (*c*) with the Pressure Anemometer (*d*) which has been observed at Utrecht for 25 years, and the comparison of which is made at intervals in summer and winter. The observations extend over more than a year altogether. Robinson's Anemometer was placed at the same height as the pressure plate and on the same building. It is a pity, however, that the instrument was not self-registering; it was only read at the usual hours of observation, namely, 8 h. a.m., and 2 h., and 10 h. p.m. Then the average velocities during these spaces of 10, 6, and 8 hours were computed and compared with the average pressure of the same eight hours. I am now preparing a method for reading it every hour to avoid the inconvenience arising from the fact that the difference of pressure and velocity is sometimes too great. In such a case it is not allowed to take averages, a practice properly forbidden if a function depends on a higher term than the first.

Indeed I found that in those intervals in which the force of the wind was very variable, the relation between velocity and force seemed to be somewhat different. In each case when heavy gusts of the wind occurred which were considerably stronger than the average force, the force was found to be greater than that given by the formula, even though the force of such a gust was not taken into account.

I do not think it necessary to communicate all my observations. In general I must say that, for the same velocity the pressure at one time was double what it was at another, as may be seen from the observations of March, 1874, which have been chosen for an example.

In the first column you find the average velocity per hour.

In the second column on the same line, are the corresponding measures of pressure which had been observed during the 30 days 2–31 March; three observations having been taken each day.

By the method of least squares I found the constants of the formula—

$$f = a + bv + cv^2$$
$$a = \quad +2$$
$$b = \quad -0{\cdot}06$$
$$c = \quad +0{\cdot}058$$

having given the weight 1 for every five observations. So I had 50 observations for the velocities between 2 and 11, and I gave the weight 10 to each of these determinations and so on.

Now it is probable indeed that a will be negative, that is to say, that for a velocity 1 the pressure meter will give such a small indication that it is noted as 0 while its indications should have some value. Besides this it is not probable that b should have a negative value, therefore I have preferred to take a only -1 in order that b might be positive, and I have calculated another formula approximative enough from 2—

$$f = -1 + 0{\cdot}2\,v + 0{\cdot}04\,v^2.$$

With this formula, though it does not give the least differences, the deviations, or the values calculated from the real observed ones, are not too great.

Only comparisons made at small intervals of time will give better agreement.*

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* I am, however, afraid that even then the observations would have no great value. Anemometers *of every kind* depend more than any instruments on local circumstances, and we shall be obliged to observe direction and force from captive balloons, which alone can give the true wind,—the wind which in general will eventually come down to the surface of the earth and which is the origin of the surface wind.

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MARCH 1874.

Velocity in English Miles.	Pressure in Kilograms on the Square Metre.											
1–2	0·0	0·0										
2–3	0·4	0·0	0·3	0·0	0.5							
3–4	0·1	1·2	1·1	1·1	1·0	0·9	1·0	0·5	0·2	0·0	1·0	
4–5	0·2	0·6	1·3	0·1	0·1	1·5	1·5	1·5	1·0	1·7	1·5	
5–6	1·1	1·2	0·8	1·3	0·8	0·8	1·4					
6–7	2·4	1·5	1·7	3·2	1·6	2·0	2·1					
7–8	1·3	4·5	3·1									
8–9	9·5	1·7	2·6	3·0	2·4							
9–10	2·5	3·2	4·4	2·0	6·0	3·3	4·8	2·4	3·3	13·0	5·5	4·7
10–11	5·2	5·2	8·5	5·6								
11–12	8·1	4·5	8·1	15·5								
12–13	8·6	11·8	6·8	9·8								
13–14	10·4	16·2	4·6									
14–15	14·6	28·3	13·0	15·0	19·7							
15–16												
16–17	16·9	20·4										
17–18												
18–19												
19–20	33·7	35·7										
20–21												
21–22												
22–23												
23–24	32·0	33·6										
24–25	36·5											

For the other months I give only the average amount of pressure from 1873 to September 1874 for each degree of velocity by Robinson's anemometer (English miles).

Velocity.	Observed.	—	Velocity.	Observed.	—	Velocity.	Observed.	—
1–2	0·4	0·3	9–10	5·3	6·4	17–18	16·9	18·2
2–3	0·6	0·2	10–11	6·2	7·6	18–19	19·1	20·1
3–4	1·2	0·9	11–12	7·0	8·7	19–20	26·7	22·0
4–5	1·4	1·6	12–13	8·2	10·3	20–21	26·2	24·0
5–6	2·2	2·4	13–14	9·7	11·7	21–22	33·3	26·1
6–7	2·3	3·3	14–15	11·9	13·2	22–23	—	—
7–8	3·2	4·3	15–16	13·2	14·8	23–24	32·8	30·0
9–9	5·0	5·3	16–17	16·7	16·5	24–25	36·5	32·8
						25–26	30·1	35·1

BUYS BALLOT.

On the REDUCTION of the DEGREE of FORCE shown by my WIND GAUGE to VELOCITIES of WIND. By H. WILD.

As already stated in my description of the simple Wind Gauge (Appendix XI. to the Report of the Proceedings of the Meteorological Congress at Vienna), the values there given for the conversion of the direct indications of the anemometer in question to wind velocities in metres per second are based upon the empirical verification of the instrument by means of Combes' apparatus for testing anemometers which M. Dohrandt, one of the assistants at the Central Physical Observatory, undertook at my request. At the time of drawing up my report M. Dohrandt had not finished his experiments, and their subsequent continuation made it necessary to correct the data first given by the anemometer in question in another way with regard to the wind actually

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blowing at the time of the observation. The results of these experiments, and an account of the whole method of procedure, are given in detail in a work by M. Dohrandt just printed, entitled "Determination of Anemometer Constants."*

The anemometer from which my former results were obtained is that denoted by No. 5 on p. 55 *et sqq.* of this work. Its plate was 0·3 metre long by 0·15 metre broad, and without the fitting at the upper end 195 grammes in weight, but the total weight with the latter was 245 grammes.

For comparison I give here the correct values taken from p. 58 of the work in question, together with the results contained in my report:—

Velocity in Meters, per Second.	Angle of Deviation of Plate in		Difference.
	Earlier Experiments.	Later Experiments.	
1	(2·0)	(2·0)	0·0
2	7·0	(6·5)	− 0·5
3	14·0	12·1	− 1·9
4	22·8	20·2	− 2·6
5	32·7	29·0	− 3·7
6	42·3	38·0	− 4·3
7	52·6	47·4	− 5·2
8	62·0	56·2	− 5 8
9	66·3	63·5	− 2·8
10	69·9	66·6	− 3·3
11	(72·6)	69·5	− 3·1

The numbers in brackets are graphically interpolated.

There is therefore not an inconsiderable difference between the results of the older and the more correct new experiments, and in consequence of fresh trials it will probably increase, owing to a further correction of the latter.

As M. Dohrandt has already explained in the introduction to his work, his attachment to a scientific expedition to the Amu Daria (Oxus river) for one year, has unfortunately prevented him from adding his theoretical deductions to his abundant materials, which might have led to the grouping of facts under general points of view, and so to the deduction of laws and formulæ.

But the importance of the subject seemed to me, however, to admit of no long delay, and so, with the consent of M. Dohrant, I have requested Dr. Mägis, another assistant at the Observatory, to undertake these theoretical investigations, and, if necessary, further experiments, in order, if possible, to bring the matter to an end. Dr. Mägis most readily undertook the solution of this problem, and with evident success. His inquiries so far in the matter have proved beyond doubt that to the final results given by M. Dohrandt for the wind plates, at all events with great velocities, an increasing correction to 10°/₀ of the total amount must be applied, owing to the fact of the correction due to centrifugal force having been neglected in the experiments with Combes' apparatus, and the above angles of deviation, according to the last experiments, will differ even more from the former ones.

It would therefore be premature, before Dr. Mägis has completed his zealous inquiries, to wish to establish a law of the dependence of the angle of deviation plates upon their weight based on the experiments of M. Dohrant with heavy plates, and to apply the same to the modification of anemometers for the purpose of measuring heavy winds.

St. Petersburg, 16th August 1874.

* "Repertorium der Meteorologie," Vol. IV., No. 5, not yet published.

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APPENDIX D.

REPLIES to the QUESTIONS of the PROGRAMME proposed by the PRESIDENT in his CIRCULAR No. 2 of the 6th JUNE.* By Prof. G. CANTONI.

Recommendation of new instruments.

1. I recommend again the psychrometer, *à ventilateur*, for determining the relative humidity of the atmosphere (*see* the description in the *Norme*, &c. annexed). The psycrometrical observations made in Italy since 1866 with this instrument, and published in the *Riassunto*, &c. (which I also annex), demonstrate sufficiently that this simple instrument may render the observations made under very different local conditions tolerably comparable between themselves.

Best mode of comparison of instruments.

2. Above all, the Central Meteorological Institute of each country should undertake the comparison of the instruments which it supplies to the principal stations while determining the curves or the formulæ for the corrections of each instrument. It should also see that the observations are made on uniform rules, and assure itself of this by frequent inspections. Afterwards the International Committee should undertake the comparison of the standards of the different central institutions by direct inspections by some of its members.

Selection of central observatories.

3. The selection had better be left to each central institution in countries having a certain extent of territory. On the contrary, the International Committee should make the selection as regards small countries, or regions in which no meteorological system has yet been organized. In Italy there does not yet exist a real central observatory, but it is proposed to establish it at Rome or Florence. There is at present at the Ministry of Agriculture a central institution, over which I have the honour to preside, and which has the charge of collecting and publishing the meteorological observations made at 60 stations. For the principal stations (20 in number), the observations, taken thrice daily, are published in a ten-daily bulletin. This bulletin, which is sent to the central institutions, may serve for the purposes of general or international meteorology. The 10-day and monthly means of the observations made at all stations in the interest of local climatology are published in a monthly bulletin. There is also an office at the Ministry of Marine which receives and transmits for the benefit of seamen daily telegraphic reports on the state of the weather and the sea.

Duties of such central observatories.

4. At the central observatories the values of the different meteorological elements (pressure, temperature, &c.) should be registered at least every quarter of an hour by means of self-registering instruments, and the values should be checked by direct two-hourly or three-hourly observations. Observations should be made on terrestrial magnetism, atmospheric electricity, solar radiation, and generally on all phenomena which cannot be studied at all observatories of the second order. Lastly, everything should be undertaken which I have mentioned with respect to the second question.

In countries where no central observatory is yet established, there should be at least a central institute or office, nearly as I have said of Italy with respect to the third question.

Minimum of observations to constitute a station of the second order.

5. At the stations of first and second order, there should be at least three observations daily, suitably distributed according to the decision of the Congress of Vienna. It is even desirable that an agreement should be come to on the choice of hours, but it is difficult to satisfy equally the different customs and physical conditions of the various countries. A simultaneous observation should also be made agreeing with that at Washington, in accordance with General Myer's proposal. More than 20 stations in Italy have done so for several months past.

* This circular has not been reprinted, as its contents have been incorporated in the Programme (p. 4).

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What observations should be published, and how should MS. observations be preserved.

6. The publication of observations of general or international interest, as I have stated in the third question, should be carried out by the direction and at the cost of the Government of each country or district. It is difficult to fix in advance the number of stations which should contribute to these publications, some general rules only can be established. My *Considerazioni* (which I annex) can be referred to as to the classification of meteorological stations in Italy. All these stations send every ten days a copy of all their partial observations, and this is preserved in the archives of the Central Institute of the Ministry of Agriculture, in order to satisfy all the researches which may be made with them even by the Central Institutes of other countries, or by the International Committee.

Adoption of a uniform scheme for publications.

7. In publications of general interest, that is, those intended for international communications, a certain uniformity should be decided without interfering too seriously with the precedents of each central institution. I recommend for us the form of the *Bolletino decadico* (*see* the copy of the first decade of August, which I annex), in which however, I am willing to introduce some modifications according to the wishes of the committee. On the contrary, in publications which have only a local interest, as for instance, our *Bolletino mensile*, (*see* the copy for the month of March, which I annex) it will be well to leave a greater freedom in the form, limiting ourselves to certain general recommendations.

Interval of publication for international observations.

8. With respect to the international communications, in addition to telegraphic reports, I desire that preference should be given to publications in decades. Monthly and yearly communications always arrive too long after the events or disturbances which it is wished to study over a large area.

I would also recommend that the beautiful undertaking of the synoptic charts by Capt. Hoffmeyer which I should like to see extended to North America should be encouraged and aided. My Government will not refuse to purchase a good number of copies.

Form for international publications.

9. For international communications I prefer the form given to the *Bolletino decadéco*, where the values of a single meteorological element observed three times daily at all the principal stations are exhibited in the same table, so that it is easy to see the march of the disturbances, and one can easily discover whether there is any error in the local readings.

What centres for international investigations should be constituted.

10. I prefer seeing the different meteorological phenomena which are closely related to each other grouped in one paper or an international publication, than to see the study of several kinds of phenomena distributed among different persons. This need not prevent special studies from being made on the laws of phenomena, considered over the whole surface of the earth. The central observatories or institutes of the great countries, and the International Committee will be able to come to an agreement on the distribution of the aggregate work between them.

Funds for the support of such investigations.

11. It seems to me easier to induce each country or central institute to purchase a certain number of copies of the different international meteorological publications. But for certain general studies and investigations it is necessary that the same countries should establish a common fund whose administration should be managed by the International Committee.

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APPENDIX E.

CIRCULAR respecting the COLLECTION of REPORTS on the ORGANIZATION of the VARIOUS SYSTEMS of OBSERVATION.

A proposal was adopted at the Meteorological Congress of Vienna (App. 2. to Protocol of the 3rd meeting), to request the directors of the various systems of meteorological observations to send in reports on the organization of the latter.

A comparison of these Reports would best show the present state of practical meteorology in the various countries, and also what changes and improvements should be introduced for bringing about greater uniformity and precision.

I have the honour, therefore, to request you to be good enough to send a report in the above sense by the end of May 1875 at the latest, to the undersigned President of the Permanent Committee.

To facilitate the comparison of the Reports, I have ventured to draw up the following questions. Even in the case of these questions having been wholly or partially answered in any publication issued from your Institution, the Permanent Committee would be much obliged if you would take the trouble to reply to them briefly.

In the event of there being any printed Instructions for the stations of your system of observations, I venture to request that you will send the same, as the Vienna Congress, at its meeting of the 13th September took into consideration the project of drawing up general instructions, and referred the same to a special committee.

(A.) *Questions relating to the Central Institution.*

1°. Are the details of the organization of your system of observations published, and if so, in what work?

2°. When was your Central Institution established?

3°. Does it include several departments, and if so, for what lines of action? Is there a Magnetical Observatory connected with your establishment?

4°. Is the financial estimate of your institution published, and if so, where?

5°. Are Weather Reports regularly sent to your Central Institution, and if so, from how many inland as well as foreign stations? In what way are these telegraphic reports worked up? Are the weather bulletins published in the daily newspapers, and by which?

6°. Do the stations of your system take part in the scheme of synchronous observations initiated by General A. J. Myer, and which are these stations?

7°. In what manner are the barometer observations reduced to sea-level?

8°. What improvements and extensions in the organization of your system of observations do you consider necessary, or desirable.

(B.) *Questions relating to the Stations.*

1°. What elements are included in the observations at most of your stations?

2°. Are there several classes of stations, according to the definition of the Vienna Congress? (IX. Meeting, App. I.) Are there special stations for the calculation of rainfall, and others for the investigation of the tracks of thunderstorms, and the distribution of hail?

3°. What is the number of stations in each class?

4°. Are the stations regularly inspected, and at what periods on an average?

5°. Is a description of the instruments used at the stations of your system published, and if so, in what work?

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6° (*a*). What kind of barometers are used at your stations? Syphon barometers, fitted with or without microscopes, barometers on Fortin's principle, or such cistern barometers in which a change of level of the cisterns is provided for in the scale (as in Adie's barometers), or by calculation (as in Kappeller's barometers). Are Aneroid barometers used for the observations?

(*b*.) What is the average error in a comparison of your barometers with the normal barometer? What is the average constant difference between the station barometers and the normal barometer?

(*c*.) From what maker do you get the station barometers, and what is their usual price?

7°. What kind of thermometers are used at your stations?

(*a*.) Are your thermometer bulbs spherical or cylindrical?

(*b*.) Are the thermometers graduated on the stem or provided with a special scale?

(*c*.) What is the exposure of the thermometers? are they placed outside a window, or in the free air, in the shade of the house, or over an open grass-plot?

(*d*.) What kind of screen is used for your thermometers, and especially of what material? Are they fixed or moveable, according to the sun's position? are they protected from terrestrial radiation?

(*e*.) At what height above the ground are the thermometers placed?

(*f*.) Is an arrangement for ventilation used for the thermometers? Is the rotatory thermometer used?

(*g*.) Whence are the thermometers obtained, and what is their price?

8°. Are maximum and minimum thermometers used at your stations, and on what principles? By whom are they made, and what is their price?

When are the maximum and minimum thermometers read?

9° (*a*). What is the construction of your rain gauges? Of what material are they made?

(*b*.) What size is the receiver of the rain gauges at your stations? Is it circular or square?

(*c*.) At what height above the ground is the receiver of your rain gauges?
(*d*.) What is the price of such a rain gauge, including the measuring glass?
(*e*.) What method is used in measuring snow?
(*f*.) At what time of the day is the fall measured?

10°. Do the stations possess a special wind-vane for recording the direction of wind, or are the observations made by the vanes on steeples, or from the direction of smoke, &c.?

11°. Is the wind force estimated, and by what scale? Or do you make use of simple dial instruments (Robinson's Anemometers), or vanes with pendulum-like wind gauges (Wild's or Prestel's Anemometers)?

12°. Is the amount of evaporation measured at any of your stations, and by means of what apparatus? What is the extent of the evaporating surface? Is the atmometer protected from sun and rain, or is the evaporation measured on an open surface of water?

The above questions by no means exhaust all the circumstances to be considered in the establishment of a Meteorological system, but they contain the principal points, and the Permanent Committee do not wish to take up too much of your time and trouble in answering a too comprehensive series of questions.

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Station__ _____

Height above M.S.L._____ ft.

Day.	Barometer.			Air Temperature.				
	7	1	9	7	1	9	Max.	
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
Mean								

Station_____

Height above M.S.L._____ ft.

1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								

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187___. Long._____

Month _____ Lat._____N.

in.	Tension of Vapour.			Relative Humidity.			Wind. Direction and Force.			Amount of Cloud.			Rain-fall.	Remarks.
	7	1	9	7	1	9	7	1	9	7	1	9	—	

187___. Long._____

Month_____ Lat._____N.

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APPENDIX G.

Professor H. WILD, Central Physical Observatory, St. Petersburg.

When the question of the establishment of an International Meteorological Institution was first mooted, I was, on many grounds, a decided supporter of the idea in its most extended development. But the experience which I have gained at the Meteorological Congress of Vienna and subsequently has so materially changed my views on this question, that now I can only consider such an institution really useful in the most moderate degree. The reasons which have led me to this change of mind will be gathered from a detailed discussion of the several duties which, in the widest sense, were to be undertaken by the Institution in question.

1. Some persons have proposed that a certain number of meteorological stations should be selected in each country as *international stations*, that these international stations should observe on precisely the same plan, be placed under the International Institution, and, *with the view of studying general weather phenomena, should forward their observations direct to this Institution, which would publish them in full and discuss them.* The number of stations to be selected in each country would be regulated by the above object. If we make a very low estimate the number of stations for Europe alone would amount to at least 100, and for the whole surface of the globe at least 1,000. Now anyone who but for a short time has had the direction of a moderately large system of meteorological stations knows that, irrespectively of the diversity of languages, it is absolutely impossible to superintend from one point 1,000 or even 500 meteorological stations, distributed over the whole globe. Even if we assume that the central institutions of the individual countries would undertake the direction of these international stations, and send in properly checked observations from the same to the International Institution, the mere publication and discussion of this enormous mass of original observations at one place, if it be only moderately well done, must be denoted as a thing impossible. The principle of division of labour is certainly here the only correct one; each country should publish the observations from a selected number of stations, and adhere to a common fixed form of publication, to allow of the easy comparison of the data of the different countries. This also offers the advantage that stations of one and the same country shall not be treated in a totally dissimilar manner, or be altogether separated from each other in publication, if the central office of the country deems fit, in the study of local phenomena of weather, to publish *in extenso* the observations of other than the international stations. As the form of publication of the observations taken at the remaining stations of a country will be left entirely to the latter, margin enough is left in any case for individual freedom, without, on the other hand, compromising the interest of the whole, *i.e.*, of the Science, by giving too much option in the matter. It has already been decided by the Congress that a uniform plan of publication for a selected number of stations in each country, and for, say, three observations daily, is desirable, and there are indications that this desideratum will be carried into effect at no distant time.

2. Presuming, therefore, that the Central Institutions of the individual countries will themselves provide for the publication of the observations of a selected number of stations according to a uniform pattern, the task of the International Institution in this respect would be *to deduce general results from the total mass of publications sent to it, e.g.*, to utilize them in the construction of synoptic charts for the whole surface of the earth, or at least the greater part of it. But even this problem is not to be solved without the active co-operation of the different central institutes, the simple reduction of the barometer observations to the sea level for the investigation of the distribution of pressure, requires a great amount of information respecting the conditions of the several stations which can only be sufficiently known and

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forthcoming at the central institutions. Here also a division of labour is again called for, and moreover, for the most part, already exists, as in most countries meteorological bulletins and small synoptic charts, with barometer readings reduced to sea level, are published, and the data and tables for effecting this reduction and other analogous preparatory work have in some cases been already given. It only remains then for the International Institution to construct synoptic charts for extensive areas of the earth's surface, and to use the same in the deduction of general results.

3. Some meteorologists have made the proposal to extend as much as possible Dr. Buys Ballot's *tables of deviations*, and to transfer the collection of these data and their conversion to uniform measures for all countries to the International Institution. If these tables, like Dr. Buys Ballot's for Europe, only contain the deviations of the actual daily means of temperature, pressure, &c., from the normal values, no very great benefit to Science can result therefrom in the present state of Meteorology; if, however, they give the deviations for individual hours of observation this task coincides in the main with that above noticed. Weather is so variable that importance can only be attributed in future to mean states of the atmosphere in climatal investigations, and for reductions like those to the sea level, determination of deviations, elimination of periodical influences and the like, but not for the discussion of non-periodical weather phenomena. If, however, we keep to the individual observations, taken as far as possibly simultaneously, then, as the Congress has already acknowledged and stated, the reduction to the sea level, at least for the barometer, will be more appropriate than the method of deviations in determining the laws of the movement of the atmosphere. But it must not be said that I do not fully recognize the value and importance of the laborious and excellent works of Dr. Buys Ballot in the past; but where, as is the case here, it is a question of organizing something to be generally adopted for the future, the requirements only of the present time can be decisive.

4. As a further task for the International Institution have been mentioned the collection of the normal values of the different meteorological elements for a great many points of the globe, and the utilization of the same in drawing up tables, and the construction of charts of isotherms, isobars, &c. The solution of this problem too would of course be impossible without the active cooperation of the various central institutions in sending in trustworthy and well sifted data.

5. Lastly, the International Institution was to be a station for carrying on meteorological experiments, where investigations on the improvement and development of meteorological methods and instruments should be made. To solve this problem perfectly at one place only would however be scarcely practicable. For instance, it would hardly be possible in Holland to test the usefulness of certain hygrometers in case of very great dryness of the air.

Now, if we consider these functions of the International Institution, they have, as we see, so much in common that they presuppose for their discharge the existence and well-ordered efficient activity of a central institution in each country. If any one of these institutions does not work well this would exert at once a disturbing and obstructing influence on the activity of the International Institution. My opinion then is that the prosperous efficiency of the various central institutions would be very much compromised by the proposed transference of the above duties to an International Institution. If this should take place all activity of a general character would be withdrawn from the central institutions; in respect of the discussion of observations they would be limited in future to investigating the special conditions of their own country, and would only learn the general laws of weather as results of the labours of the International Institution. The inevitable consequence of this will be a diminution of interest for general meteorology, and especially of the comprehension of the requirements and difficulties of the treatment of the subject as a whole; in proportion, however, as this interest and comprehension vanishes, that part of the work of the central institutions which has more special reference to general questions will also suffer, local interest will begin to predominate and the whole suffer thereby.

Therefore I should consider it better and more appropriate that the money which each country would have to contribute to the International Institution

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should be applied at the several central institutions in providing one or more assistants, who should, so to say, devote themselves exclusively to general meteorology. The central institutions would exchange among themselves all observations and data which they would have communicated to the International Institution (which, moreover, is now done), and the above-mentioned functions should, on the occasion of Meteorological Congresses, or else according to the disposition and capability of the respective officials and other special circumstances, be so distributed that, for example, one central institution should undertake the construction and discussion of comprehensive synoptic charts, another the discussion of conditions of temperature over the whole globe, a third the distribution of pressure, another the treatment of rainfall, &c. And so one central observatory would make the subject of its special business in this direction investigations and improvements on the observation of air-temperature, another similarly on the hygrometer, a third studies on clouds, &c. In such a manner each central institution and principal observatory would remain in constant connection with general meteorology, and in active exchange of materials of observations and results of investigations with all the other sister institutions, and thereby not only be led on to new activity, but will retain a liking for the work. And if, under any circumstances, a central institution, contrary to expectations, should not properly perform its duties, the whole will in any case not suffer to such an extent as if, as is also conceivable, the International Institution did not work as might be wished. If we conceive, however, that for such an institution, founded on a grand scale, each great power would have to contribute a yearly grant of at least 7,000 thalers, we should certainly consider such a sum, if appropriated to the respective central institution, sufficient means to solve one of the above problems in a very satisfactory way.

If the above view is approved, the following only of the functions proposed for the international institution would remain:—

1. The establishment and direction of special international stations, at common cost, in less civilised countries, and the publication of their observations.
2. The establishment of communications between the several central institutions, *e.g.*, of the exchange of their publications, &c.
3. The control of the execution of the decisions of the Congress from time to time, correspondence with the several central institutions in respect of the preservation and development of uniformity of observations, organization of new congresses, &c.

I maintain that the first of these three problems would be better solved if the civilized country lying nearest to the less civilized districts in question, or having most relations to it, should undertake the establishment of such stations, through its central institution, and that the latter should publish the observations, as is already often done.

The two other functions would certainly be best performed by an international institution, and are in reality handed over, as a preliminary step, to the Permanent Committee. If the latter should be able to deal with them sufficiently, this mode would be the simplest, and the International Institution quite unnecessary. But if this should not be the case, these few remaining functions would so limit the scope of the institution that its creation could not meet with serious difficulties. The end would be served by giving to the President of the Permanent Committee a secretary, at common costs, and by defraying the expenses of the office and printing by contributions, as is now already done to a smaller extent.

Dr. C. Jelinek, Central Meteorological Observation, Vienna.

With respect to the question of the establishment of an International Institution for the purposes of meteorology, which has been referred to the decision of the Permanent Committee, my opinion is that the establishment of such an institution is necessary, if the Meteorological Congress of Vienna is to have practical results; but that it is very difficult to assign to it such a sphere of action as shall not clash with the operations of the individual central institutions, and induce the directors of these institutions to abandon certain lines of

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action hitherto prosecuted by them, and to adapt themselves to the arrangements emanating from the International Institution.

When Köppen first published his proposal with regard to the establishment of an international central meteorological institution, the chief difficulties appeared to me to be on the part of the Governments. I have since arrived at the opinion, and I here openly acknowledge it, although it may find objection in some quarters, that the chief difficulties will arise with the several directors of the central meteorological institutions.

I think that the Governments might be induced to contribute towards general meteorological objects, provided that the demands made upon them were confined within moderate bounds. The amount quoted by Köppen (250,000 francs) must be greatly reduced, perhaps to the 10th part. The Governments of Italy, Portugal, and Austria have already declared themselves ready to assist in principle, and there can be no doubt that the other Governments, at least the majority of them, will follow this example.

We must, however, abandon the idea of an international publication, in the sense of discontinuing the publication of original observations by the various central institutions.

There remain, then, as common subjects of activity:—

(*a.*) The establishment of stations in remote districts.
(*b.*) „ „ on mountains.
(*c.*) Investigations of an instrumental nature, and experiments.
(*d.*) Publication of the observations of such stations as do not fall within the network of observations of existing central institutions, or which are not published by the latter.
(*e.*) Construction of daily meteorological charts for Europe and Asia, on the basis of trustworthy, and as far as possible of complete, data; and discussion of atmospheric disturbances.
(*f.*) Continuation of the investigation into the conditions of temperature of the earth, as treated in such an admirable manner by Dove, with the utilization of the most recent and trustworthy data, in which I would urge the grouping of the aggregate materials (including the older) in a uniform manner, and expressed in the same units of scale.
(*g.*) Discussion of the rainfall of the earth (omitting perhaps North America, for which we have Schott's excellent work) in a similar manner to that done by Raulin for South France, and Schott for North America, in which one and the same measure, millimètres, should be used. Many other general problems of a similar nature might be found.

The method of solution will, I think, be by the Permanent Committee distributing the work among the different directors of the central institutions or other meteorologists, and coming to an agreement with them as to the investigation to be undertaken, as well as regarding the cost and duration of the same. This assistance should be so calculated that not only the cost of printing should be covered, but that each person undertaking such work should be enabled to engage suitable assistants for a certain time (perhaps from 1 to 3 years, with permission to increase the period).

A portion of the specified subvention must of course be voted to the President of the Permanent Committee for the payment of an assistant, defrayment of printing, postage, and other ordinary expenses. According to this my proposal, the International Institution would really amount to an organisation on a permanent footing of the present so-called Permanent Committee. The operations of a general scope, however, need not be carried on at one and the same place; on the contrary, a distribution among the different institutions seems desirable, and the engagement of meteorologists not connected with them; in the same way the general publications might be most conveniently done at the place where the materials have been discussed.

Perhaps at a later period, when the activity of the Permanent Committee shall have borne fruit, a further step may be taken towards the creation of an International Meteorological Institution. In the meantime I must look upon any precipitate action as serious; especially it appears to me dangerous to refer all general problems to one and the same central institution.

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R. H. Scott, F.R.S., Meteorological Office, London.

I do not know that I can add much to the remarks which I made at Vienna on the subject of the proposition for an International Meteorological Institution.

However theoretically desirable such an establishment may seem to be, it appears to me that the difficulties to be met with in calling it into existence are so serious as to preclude any present possibility of carrying out the project to a practical issue.

I am, therefore, decidedly of opinion that the efforts of meteorologists should be devoted to working out each for his own country, the various problems of the science on principles in as close harmony as is possible with those followed by adjacent countries.

I may further state that, having consulted the Meteorological Committee of the Royal Society on the subject, I am informed by them that they do not think that it would be of any practical utility at present to bring under the notice of the British Government a proposal for the establishment of an International Meteorological Institution.

Professor G. Cantoni, University, Pavia.

I have carefully examined the remarks of MM. Wild and Jelinek on this question, according to the communications made by our President.

I do not think it convenient that an international institution should be established until such time as the Permanent Committee shall have accomplished the duties assigned to it by the Congress of Vienna, which elected it, because the Committee derives its powers direct from the representatives of the European states.

It will, however, be useful that the Committee should formulate a detailed proposal on this object, in order to submit it to the deliberations of another International Congress, as proposed by the Congress of Vienna after a lapse of five years.

It is also very desirable that the Committee should come to an understanding with the central institutions of the principal countries in order to resolve the difficulties respecting the objects and limits of the publications and investigations which should be entrusted to the International Institution. In the same way the Permanent Committee should directly influence the Governments of the principal countries in arranging the amount of a special vote for this purpose.

I shall now make a few remarks on the above proposals of MM. Wild and Jelinek.

I think with M. Wild that it would be very difficult for the International Institution to accomplish by itself all the work of reduction and collation of all the observations made at the principal stations of the different European countries. As I stated in my communication of yesterday it would be better to leave to the Central Institutions of these countries the care and the work for the respective districts. Thus each one is more interested in promoting the progress of the work, and is better able to present in a definite shape the observations made at the stations under its direction.

I also agree with MM. Wild and Jelinek that the International Institution should undertake simply:—

1. The publication of the results of observations taken at stations which do not depend upon any central institution, while promoting the establishment of new stations in more distant or more important regions.

2. The construction of charts or meteorological maps to assist in the determination of the laws of the principal meteorological and magnetical phenomena of the globe. The plan proposed by Captain Hoffmeyer should be aided and favoured.

3. The making of experiments on instruments most suitable for observations at meteorological stations of different orders.

4. The facilitating of communications between the central institutions, for the adoption of uniform regulations for the exchange of publications.

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On the other hand, I do not agree with them as to the idea of the division of meteorological studies in such a way that one person or central institution should undertake exclusively a certain class of facts in collecting all the data relating to the whole of the globe. The division of labour in every art is useful when it recognises the relations existing between the different parts of a system or organism. The International Committee or institution has been conceived precisely with the view of preparing the materials which lead to the discovery of the general laws of the variations of weather, and these are the result of the contemporaneous and successive reciprocal influences of the different meteorological elements (Temperature, Pressure, Winds, &c.). Hence the above-mentioned division of studies would hinder instead of assisting the discovery of these laws.

Dr. C. Bruhns, Observatory, Leipzig.

The different views which have been promulgated at the Vienna Congress respecting the establishment of an international institution has made it appear to me almost impossible to found such an institution, towards which all states should contribute. The Governments would hardly vote money to an institute over which they can exercise no influence, and at which they are not always represented.

As MM. Buys Ballot, Jelinek, and Wild have already stated in their proposals the several functions which would fall to an international institution, I shall summarize these functions in the following words.

The International Institution has to promote Meteorology in every way, and with this object, to advise and carry out works of general scope.

The International Institution would, I think, be most practicably brought into existence by the establishment of a *Meteorological Society*, whose members should hold periodical meetings, at which investigations suitable to the state of the science at the time should be considered, and be entrusted to a Council for execution.

This Meteorological Society should keep up the communication between its members by means of publications, and in fact by a periodical Journal, in which should be given uninterrupted reports on the carrying out of the decisions and other important communications, and also by publications at irregular intervals, containing the observations of remote foreign stations, meteorological charts, discussion of atmospheric disturbances, &c.

Each member should receive the publications gratis, in consideration of a certain contribution. In like manner the institutions which pay a similar contribution, and would possess in their directors representatives with right of voting, &c. If the contributions of the members should not cover the expense of printing, the Governments must be requested to grant a yearly sum to the society, in the same way as is already done for some academies, *e.g.*, the Royal Leopold-Caroline Academy. In consideration of this support the respective States might receive a number of copies of the publications.

It is hoped that by this means sufficient funds will be received to enable the President to engage and remunerate a number of scientific men for the preparation of publications and other operations.

If, lastly, every member would bind himself to forward his own meteorological publications to the International Society, a library unique in its kind would be created in time, which would offer to the members data and means for carrying out meteorological investigations of every kind.

The Meteorological Society must have the civil rights of an individual, to be able to receive presents, invest money, &c., and gradually endeavour to obtain a capital in funds as well as in moveable property.

The locality would of course be settled by the society itself, and would mainly depend on the residence of the President.

These explanations will suffice to show that I consider the international institution as a purely scientific organ, to promote Meteorology in all directions, and yield works which in time will be of lasting value for Meteorology.

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Professor E. PLANTAMOUR, Geneva, to Mr. SCOTT.

I have just read the article published by M. Wild in the last number of the "Zeitschrift der oesterreichischen Gesellschaft für Meteorologie" (15th August); my first idea was to address to M. Jelinek a letter with the request to insert it in his Journal, in which I should have explained the object, the scope and the attributes of an International Meteorological Institute, which I understand in a manner quite different from the establishment combated by M. Wild in his article.

I was prevented therefrom by several reasons:—first, the accumulation of arrears during my absence leaves me at present no time for preparing a detailed report upon this question, and further, I have some hesitation in addressing myself to M. Jelinek, whom I know to be a declared opponent of the establishment in question; lastly, M. Wild's article being entitled "Proposal to the Permanent Committee of the Meteorological Congress," I thought that it would be best to communicate with one of the members of this Committee, so that when this question should be considered by that body, the project of an establishment, such as I conceive, might be discussed, and to yourself in particular, for several reasons, among others that you scarcely took any part in the discussion which ensued on the subject in the Congress of last year. I need not say that if you should wish for any explanation or more detailed development of any points, I should be quite ready to give it.

M. Wild (as well as other members of the Congress, as far as I could perceive) is especially prepossessed with the fear that the creation of an international institution would involve the depreciation of the importance of the central institutions in the different countries. In justification of this fear, he supposes that the stations selected as international stations would be under the immediate direction and control of the international institution; he concludes therefrom that the national institutions, having no longer the direction of any stations but those of the second and third order, and having no longer to occupy themselves with any questions but those relating to local climatology, would lose much of their importance. But I have never had the idea of attributing such a function to the international institution, or of giving it the direction of any station. Everything that concerns the relations between any station whatever and the central institution of the country would remain precisely on the same footing as heretofore, and nothing would be changed in the form of publication adopted in each country. The functions of the international institution would consist in the publication of a resumé of the different national publications, a résumé in which all the data suitable for exhibiting the atmospheric movements and phenomena would be grouped in a synoptic manner, and in a form rendering them inter-comparable. The end would be attained by giving to the publication, hitherto undertaken by Dr. Buys Ballot, a development and an extension the realization of which would be impossible without the co-operation and participation of all civilized countries. M. Wild seems to think that the end is attained by collecting in the same library all the publications of the different countries, because we have thus at hand all the materials available for the study of meteorology. But if the complete collection is to be found in some great centres it is not the case with many others, and the difficulty of procuring the necessary materials is an obstacle to the undertaking of investigations which for this reason are almost unapproachable in the case of a private individual.

Then again, the form even of these publications, which contain in addition to the required data a mass of purely climatological materials, renders them very inconvenient for general investigations, irrespectively of their not being made in a synoptical manner, and their being expressed in different scales according to the various countries, &c. M. Wild estimates the amount which ought to be contributed by a great power to the work devolving on the International Institution at 7,000 thalers; I think he has greatly exaggerated it, and from what Dr. Buys Ballot has told me as to the cost of the publication of the Utrecht Annals I am convinced that an infinitely smaller sum would amply suffice. M. Wild would prefer that this extra outlay of 7,000 thalers for the meteorological service of the great countries should form part of the allowance of the central institutions, the directors of which should have special investigations made by *savans* placed under their directions.

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But would not this be to stifle individual initiation, and to monopolize all scientific research in the hands of the directors of national institutions in such a way as to have, so to speak, only an official science? The expenses relating to the organization of a meteorological system unfortunately require the intervention of the state, and everything which concerns the collection of materials in each country has an official character. A publication such as I conceive it, would place the data requisite for the study of meteorology in general in the hands of each savant, and not merely of a small number of persons owing to their official position.

Do you not think that in England, Germany, and elsewhere there are savans who would be desirous of undertaking meteorological investigations if they had the necessary materials, and who would be capable of executing them, and who on the other hand do not care to abdicate their individual initiative, and to work under the direction of the official representative of science in their country?

Lastly, I do not share the opinion expressed by M. Wild at the top of page 243, namely, that tables containing, like those of Dr. Buys Ballot, the deviations from the daily means of temperature, barometer, &c., with the normal values, have scarcely any more use in the present state of the science; but the discussion of this subject would lead me too far. I also limit myself to expressing the opinion that the reduction of the barometer to the level of the sea becomes too uncertain as soon as the height of the station is considerable, as is the case, for instance, at all or nearly all the stations in Switzerland. Having had occasion to calculate and discuss a very great number of barometrical determinations of heights, I have arrived at this conclusion.

I conclude with this remark. Has not the study of the movements of the atmosphere been too exclusively directed during recent years with a view to its application to the prediction of storms on the coasts, and to the system of warnings? I by no means wish to deny the practical importance and utility of such inquiries, only it appears to me that it is solely from this point of view that international atmospherical phenomena have been studied for some time past, and that other points of view have been completely abandoned.

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APPENDIX H.

LIST of OBSERVATIONS made at DISTANT STATIONS received by M. BUYS BALLOT.

America.—Buenos Ayres.
„ Paramaribo.
Africa.—Suez.
„ Ismailïa.
„ Port Said.
Asia.—Nagasaki.

LIST of OBSERVATIONS made at DISTANT STATIONS received at the METEOROLOGICAL OFFICE, LONDON.

Bermuda (Anemograms).
Beyrout.
Bahamas' Lighthouses.
Falkland do.
Gibraltar.
Heligoland Lighthouse.
King George's Sound Lighthouse (W. Australia).
Patras, Greece.
St. John's, Newfoundland.
Sombrero Lighthouse.

APPENDIX I.

CIRCULAR requesting INFORMATION respecting the EXISTING SERIES of METEOROLOGICAL OBSERVATIONS in various COUNTRIES.

In order to facilitate meteorological investigations it would assist materially if it were known what series of printed or unpublished observations extending over many years exist in the various countries.

The Congress of Vienna commissioned the Permanent Committee to collect and publish the data in question, and in the execution of this duty I venture to address the following questions to you, and, in the interest of science, request the favour of a reply to the same by the end of May 1875.

1. What meteorological publications have hitherto emanated from your institution? If is desirable to give the exact titles, number of volumes, years, and also the publishers.

2. What other meteorological publications of importance, especially those referring to a series of years, exist in your country? Particulars as to the titles, publishers, date, and price are desirable.

3. Are there any series of unpublished observations in your district? Is provision made for their safe preservation? Are manuscript copies of such made and lodged in any certain place?

4. Are such series of observations which are only in MS. available for use, and in what manner? Are the originals lent out, or can they be referred to where they are kept, or are copies supplied with or without payment?

5. Do any tables of the monthly and yearly mean values of the most important elements exist, especially for Temperature, Rainfall, Pressure, and Wind; or if normal values are deduced from them, a copy of the above-mentioned mean values (for each separate year), or at least of the calculated normal means, with particulars as to the number of years from which they were deduced, would be thankfully received by the Permanent Committee.

As the Committee wishes to take up as little as possible of your time in answering the above questions, I beg to state that, in the event of their having been already answered elsewhere, a reference to the publication in which they appear would perfectly suffice.

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APPENDIX K.

Resolutions of the Vienna Congress.*

The following are the Questions contained in the Programme of the Vienna Congress, with the respective Resolutions or Decisions to which they gave rise.

Questions.	*Resolutions.*
I. Instrumental.	
1. What is the best form of Barometers for stations of the second order? Is the use of Aneroids for such stations admissible?	The reply to the question respecting the mercurial barometer is to be postponed, inasmuch as it is desirable previously to obtain reports from all directors on the Barometers employed in their systems, in reference to construction and price. Aneroids should not be employed at stations where there is no other barometer, but they are admissible as interpolation instruments alongside of the mercurial barometer.
2. What mode of exposure of Thermometers for the observation of Air Temperature is the best and most suitable for general adoption?	It was considered impossible to lay down fixed rules and regulations for general adoption in the exposure of Thermometers, because regard must be had to local conditions, and the mode of exposure which is most to be recommended, in a space which is open and accessible to all winds, and at a height of 4½ to 6 feet, cannot be used everywhere. It would be desirable that investigations on the influence of height and exposure should still be carried on at the central or chief stations.
3. What is the best construction of Maximum and Minimum Thermometers?	With regard to Casella's minimum and Hermann and Pfister's metallic thermometer, the result of long experience is that these instruments are frequently deranged, and that therefore they cannot be recommended for stations in which they cannot properly be controlled and regulated. For minimum thermometers it is better to employ Amyl-alcohol, instead of ordinary alcohol, because the boiling point of the former is 356° F., and therefore there is less fear of distillation. Finally, it should be recommended in all instructions for observers to add the rule :—*by continual comparisons of the indications of maximum and minimum thermometers with an ordinary thermometer placed beside them, to obtain a control on their uniform action, and the corrections which are to be applied to them.* As the Congress has fixed the end of the meteorological day at midnight, it is desirable that the maximum and minimum should be noted at the last observation of the evening, and entered on the day on which they are taken.
4. What instruments should be employed for determining the intensity of Radiation, and in what way can the comparability of the results obtained be ensured?	Experiments on this subject are recommended to physicists and directors of the central and normal stations, but cannot as yet be brought into the sphere of regular observations.

* This summary has been prepared, at Professor Wild's request, by Mr. Scott, as Secretary.

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5. What apparatus is the best for determining Earth Temperatures?

At what depths should the observations be taken in order to attain the uniformity which is desirable?

It appears that Lamont's method, with the use of a wooden tube, gives more trustworthy results than the thermometers with long tubes which reach into the ground, because in the latter the influence of the metal case affects the accuracy of the reduction. But on the average of the year the differences nearly compensate each other. It also appears that the aspect in which the thermometers are sunk has a great influence, and so has also the nature of the soil, so that attention must be paid to these circumstances, in order to obtain comparable results. New experiments should be recommended in various countries, in order to decide the question at what depths observations should be taken.

In order to carry the inquiry further it is recommended that classes of rocks and soils should be sought for which behave similarly with regard to the propagation of heat within them. In order to obtain more special details on this question, it must be specially recommended to the notice of the experimental stations for Agriculture and Forestry.

6. What apparatus should be employed for the determination of the Hygrometric condition of the air?

Are the Wet and Dry Bulb Thermometers sufficient?

Can the Hair Hygrometer be employed, and under what restrictions?

Although the defects of the Dry and Wet Bulb Hygrometer are not to be denied, and it is most important to recommend to physicists experiments towards the discovery of new apparatus, and some other method for the determination of Humidity, yet that hygrometer cannot as yet be replaced by any other instrument. The use of hair hygrometers can only be made with safety, if their indications are constantly controlled by comparison with the psychrometer, and their corrections from time to time determined, especially near the point of saturation, where they often give too low readings. The experiments in Russia lead to the conclusion that the use of the hair hygrometer can be recommended under the above conditions, especially for low temperatures.

Finally, experiments on the applicability of usual tables for hygrometric reductions in damp, or in very dry, air are very much to be recommended, and especially the experiments of M. Cantoni, according to which the production of an artificial movement of the air about the psychrometer brings its results into uniformity with those of the chemical method, whatever the degree of humidity may be; these should be repeated under other climatal conditions.

7. In what way can uniformity in describing the Directions of the Wind be attained?

Is the deduction of the mean Direction of the Wind by Lambert's formula desirable?

Is it desirable or not to include very light winds (force 0) in constructing Wind Roses for the Direction of the Wind?

1. To introduce the English designations of the directions of the wind: — N. = North, E. = East, S. = South, W. = West.

2. To give only 16 directions of the wind in the wind rose. In the case of intermediate directions of the wind being observed, it is proposed to count them alternately to the one side or the other.

The application of Lambert's Formula is not to be recommended, but on the other hand, the frequency and mean force of the wind which correspond to the different directions should be given in numbers. In the distribution in the wind rose those winds whose velocity is less than ½ metre per second (1 mile per hour) are not to be regarded, but are to be counted as Calms.

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The proposal of M. v. Oettingen to reduce the wind, in Direction and Force, immediately, to the four cardinal directions is considered as only suitable for special investigations.

The direction of the wind in the various strata of clouds (the cloud drift) should be observed and noted.

8. What scale should be employed for the Force of the Wind when it is determined, not by actual measurement, but only by estimation?

The Congress is not in a position to recommend a general scale for the estimation of wind force, but expresses the wish that a gradual advance should be made towards giving the velocity of the wind *in metres per second.*

9. Is it desirable to introduce simple dial instruments for determining the Velocity of the Wind?

What units should be taken for the discussion of the Velocity of the Wind?

The Congress recommends that the simple apparatus for measuring the force of the wind, which has been proposed by M. Wild, and is already used in Switzerland, Baden, and Russia, should be introduced as soon as possible at stations of the second order.

Furthermore, the Congress proposes that the velocity of wind obtained by means of anemometers should be expressed *in metres per second*, and recommends the preparation of tables for facilitating the mutual conversion of the velocity of the wind when given in metres per second, kilometres per hour, or English miles per hour.

10. What is the best form, size, and mode of exposure of Rain Gauges?

At what hour of the day should the fall be measured?

The Congress considers it best to propose for all rain-gauges a circular receiver of one-tenth square metre surface (14 ins. diameter), and to provide the edge with a strong turned ring of brass formed conically.

In the erection of rain-gauges, care must be taken that the receiver should not be less than one metre (or still better 1½ metre) (from 3 to 4½ feet) above the ground, to admit of the inspection of the receiver and of the easy removal of it. Under all circumstances, in the publication of the results, the distance of the receiver from the ground ought to be given. As to the size of the collector, no general rules can be given, inasmuch as this must be regulated according to the local amount of rain, but under all circumstances the construction of the rain-gauge must be of such a kind that the evaporation of the water collected is prevented as much as possible.

In all cases, where it can be done, the measurement of the amount should take place immediately at the end of the fall; in other cases the first observing hour of the day is recommended. The amount measured in that case is to be put down in the register for the previous day.

In a special column in the register, wherever possible, should be given the duration of the fall, expressed in hours, in addition to the quantity of rain.

11. Should the days of Rain and Snow be counted separately or together?

In the register, under the column of "Remarks," the character of the precipitation should be indicated by the symbols adopted by the Congress, and furthermore, in the monthly *resumé*, the sum of all the days of precipitation should be given and the number of days with snow, hail, and *graupel* should be especially noticed. The days are to be counted as snow days on which both snow and rain fell.

In the register two columns are to be introduced for precipitation; one for the amount of fall, the second for the depth of

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snow, while the duration of the fall, expressed in hours, is to be given in the column for Remarks.

In the publication of the yearly *resumé* should be further shown—

a. The maximum fall in 24 hours from month to month.

b. The number of days of fall which are below one millimetre (0·04 in.), and the number of those which are below ½ millimetre (0·01 in).

12. Is it desirable in giving the falls of Hail to draw a distinction between "Graupel" and true Hail?

Hail is to be described as a precipitation of frozen water, in which the stones attain such a magnitude that they may be expected to do damage to agricultural products.

It is recommended that there shall be only *one* column for "Hail," and that falls of "Graupel," but only such as are *absolutely indisputable*, should be indicated by a small star, inserted close to the entry, or by a symbol differing slightly from that for Hail. This will render it possible, besides counting the falls indiscriminately, to pick out the one exceptional case. Furthermore it is desirable that in the column "Remarks" more special details should be given of the entire phenomenon, size of stones, direction of motion and superficial extent of the hailstorm, existence or the contrary of thunderstorms, damage done, &c.

13. *a.* In counting Thunderstorms, should the Storms, as such, or the Days of storm be given?

b. In what way should the instances of Sheet-lightning be noticed?

In order to obtain values which admit better of comparison it is recommended only to count the days of thunderstorms, but this is not intended to prevent individual observers from inserting in the column of "Remarks," in addition the number of the storms, the time of their commencement, their duration, direction of motion, &c.

As days of storm only those are to be noted on which both lightning and thunder have been observed. If only lightning without thunder has been noticed, the entry for the day must be sheet lightning.

14. What apparatus is to be recommended for the measurement of evaporation?

What is the most suitable exposure for the Evaporation gauge?

As the results to be obtained from atmometers have not yet been sufficiently determined, the Congress recommends:—

1. As a general rule, for the present, to introduce observations of evaporation only at meteorological stations of the first order.

2. By careful investigation to determine what will be the influence on the results of the nature of the material of which the apparatus is made (metal, glass, baked earthenware), as well as from the colour of the apparatus, and the height of the rim of the atmometer.

Suggestions as to the pattern of atmometers, &c., to be employed will be found in the report of the Congress.

15. *a.* In what way should the proportion of Cloud in the sky be estimated and indicated?

Is it desirable to introduce for Clouds, Hydrometeors, and for other extraordinary phenomena, symbols which shall be independent of local language, and therefore universally intelligible?

The degree of cloudiness is to be given by the figures 0—10, in which 0 is to represent a sky quite free from cloud, and 10 an entirely overcast sky.

1. Entries as to the extension of clouds on the visible sky according to the scale 0—10 are to be made without reference to the thickness of the cloud. The latter is to be indicated by an exponent applied to the figure for the amount of cloud (0 slight, 2 great.)

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2. As to the forms of cloud, or rather, classes of cloud, the matters most urgently desired are more thorough observations and more accurate drawings, which will correspond to the variety of clouds which are in reality observed; as all the systems which have as yet been proposed, *e.g.* that of Poëy, are not of such a nature that they can at once be recommended for general adoption.

3. For the present it is recommended to add to Howard's designations and their combinations, epithets as characteristic as possible, according to the choice of the individual observer, in order to express the actual appearance as clearly as possible.

4. In order to facilitate a correct understanding and designation of the clouds, it is recommended,

(*a.*) That Central Offices should prepare as completely as possible lists and characteristics of the forms of cloud which occur in the district.

(*b.*) That on the part of the Congress the preparation of sketches of the principal forms of cloud be set on foot, which should be added to the Instructions for the observers.

(*c.*) That the study of the connexion between the form, constitution, and origin of the clouds be undertaken and supported, special attention being paid to the circumstance that one and the same mass of cloud presents a different appearance when seen from different sides or under different angles.

The following Symbols are proposed for the indication of Hydrometeors and other phenomena:

Rain	●	Glazed Frost ("Glatteis")	~
Snow	✳	Snow-drift	↑
Thunderstorm	⚡	Ice crystals	←
Lightning without Thunder, or Sheet Lightning	⚡	Strong wind	↗
Hail	▲	Solar Corona	⊕
"Graupel"	△	Solar Halo	○
Mist, Fog	≡	Lunar Corona	⊓
Hoar Frost	⌊	Lunar Halo	ψ
Dew	⊥	Rainbow	⌒
Silver-thaw ("Rauhfrost," "Duft")	V	Aurora	♕
		Dust haze ("Höhenrauch")	∞

In respect of their intensity, the individual phenomena are to be distinguished by the figures 0 and 2, which should be used as exponents of the symbols, in such a way that 0 should indicate very slight, 2 strong.

e.g. $●^0$ slight rain.

$●^2$ heavy rain.

It is further to be remarked that Fog (mist) is only to be entered when the observer is quite enveloped in it. Höhenrauch (dust haze), moreover is not only to be indicated by the proper symbol, but at the same time the concomitant obscuration of the atmosphere is to be noticed under the head of Amount of Cloud.

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16. Should other Meteorological Elements than those already enumerated, *e.g.*, Atmospheric Electricity, Ozone, &c., be included in the scope of normal observations, and what are the best instruments for observing them?

The institution of observations on atmospheric electricity is recommended only for head Observatories, and the decision as to the choice of the best methods of observation and of the most suitable instruments must be left to them.

The existing methods of determining the amount of Ozone in the atmosphere are insufficient, and the Congress therefore recommends investigations for the discovery of better methods.

17. Is it desirable to introduce the same Units of Measure (viz. of Length, Degrees, and Time) in meteorological inquiries in all countries, or is it sufficient to lay down certain fixed rules for the conversion of the different measures employed in the several countries?

1. For observations as well as for publications the use of the same units of measure is desirable.

2. The Congress expresses its conviction that, among all the existing systems of measure, the Metric has the best prospect of universal adoption.

3. The Congress declares it to be most desirable, if it be not possible to introduce uniform measures at present, to use henceforth only metric and English measures (with Celsius and Fahrenheit scales).

4. All action is to be supported which tends to the introduction of the uniform metric system.

The results of observation or the means should be published in the metric (and centigrade) scales in addition to appearing in the original scales.

II. Institution and Reduction of the Observations.

18. Can uniform Hours of Observation be introduced for the general observations to be made at the Meteorological Stations?

As suitable combinations of hours the Congress recommends—

h.	h.	h.	h.	h.	h.		h. h.
6	2	10	8	2	8	With minimum temperature.	8 8
7	2	10	9	3	9		9 9
7	1	9	10	4	10		10 10
7	2	9					

As the three last-mentioned observations, twice a day, at equidistant hours, give good daily means of temperature, but do not allow of the recognition of daily variations of temperature, the simultaneous use of maximum and minimum thermometers must be recommended, in addition to these combinations (but with the necessary care which these instruments require).

In each system of observation investigation should be made at a sufficient number of normal stations, as to the corrections for the most important meteorological elements (especially temperature, then pressure and humidity) which should be applied to the means of the adopted observations in order to bring them to true 24-hourly means; but monthly means of the observations should be given for the various hours of observation, and it seems furthermore desirable, when it is considered that such means may be directly used, to give the monthly means of temperature reduced to true means.

Inasmuch as between the Equator and 35° North and South Latitude, there are only very few stations existing whose daily march of temperature is known, *and not one of them has a continental situation*, the Congress should express the urgent wish that by the introduction of hourly, or at least two-hourly, obser-

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vations at suitable places, a commencement should be made to fill up this hiatus as far as possible. The systems of observation of Turkey, the East Indies, Australia, the Southern States of the Union, and eventually Brazil, should be especially requested to institute such observations at inland stations.

19. What are the rules and what the intervals of time for which the Means of the several Meteorological Elements should be calculated?

Which is the better plan, to begin the meteorological year with January or with December?

As units should be chosen,

1. The mean solar day, reckoned from midnight to midnight, of the place of observation.
2. The civil year.
3. The civil months.
4. Dove's five-day means (73 per annum).

The calculation and publication of 5-day means of temperature is recommended, in each system of observation, for a considerable number of stations, the choice of which is left to the Central Institute of the country.

It was also resolved:

1. To count the interval of 24 hours in the following way—the first 12 hours, from 1–12, as forenoon, the following 12 hours, from 1–12, as afternoon.

2. To count midnight (12 o'clock midnight) always as the end of the day, and similarly noon, (12 o'clock noon) as the close of the forenoon.

20. In what manner and for what intervals are the Normal Values for the individual Meteorological Elements to be deduced.

It was recommended to choose as the periods for calculation of normal values, intervals of five years (lustra), so that the next lustrum should begin with Jan. 1, 1876.

It was also recommended that central institutions should recalculate their old observations in accordance with the proposal, as regards the more important data.

III. Weather Telegrams.

21. Does the interchange of Weather Telegrams appear so useful that it should receive a fuller development and a firmer organisation?

The existence of a system of Weather Telegraphy in every country is declared to be a necessity.

The report of the Congress contains detailed suggestions on the principles and practice of Weather Telegraphy, and a special report on the subject has been published (p. 7).

The Permanent Committee is commissioned to propose a uniform system of cypher for Weather Telegraphy, and to circulate it amongst the directors of the several Central Institutes.

IV. Maritime Meteorology.

22. In what way can Maritime Meteorology be best introduced into the system of General Meteorology?

The Sub-Committee declares it to be very desirable that each country should, if possible, collect all its meteorological observations at one place, in order to undertake the organization of the investigations at the same place. The Institute should be established as near as possible to the sea.

The Sub-Committee is of opinion that the Institute for Maritime Meteorology, named in the first proposition, might best be placed under the general management of the Chief Institute of the country.

In consideration of the fact that it will not be possible to devote to Maritime Meteorology at the present Congress a com-

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prehensive consideration, corresponding to its importance, but, on the other hand, as it seems that a mutual understanding of the individual maritime nations in regard thereto is necessary, the Meteorological Congress declares that the convening of a Maritime Meteorological Conference is desirable.

The preparation for this Conference is to be entrusted to a Sub-Committee, to be named by the Congress. (For the Resolutions passed at this Conference, as well as the further resolutions passed at Vienna, see p. 31.)

V. Organization.

23. Is it desirable that in each country there should be established one or more Central Institutions for the direction, collection, and publication of the Meteorological Observations?

The Congress considers it necessary that in every country at least one, but in case of necessity several, Central Institutions, should be established for the management, collection, and publication of Meteorological Observations

The following definitions of the various classes of meteorological observing stations are proposed:—

(*a.*) *A Central Office*, or *Central Institute*, is the chief office entrusted by the Government with the management, collection, and publication of the Meteorological Observations of the country.

(*b.*) *A Central Station* is a subordinate centre for the management and collection of observations from a certain province.

(*c.*) *A Station* of the *First Order* is an observatory in which, without the collection of observations from other stations, Meteorological Observations are conducted on a great scale, *i.e.*, either by hourly readings or by the use of self-recording instruments.

(*d.*) *Stations* of the *Second Order* are the stations where complete and regular observations on the usual meteorological elements, viz., Pressure, Temperature, and Humidity of the Air, Wind, Cloud, Rain and Hydrometeors, &c., are conducted.

(*e.*) *Stations* of the *Third Order*, finally, are the observing stations, where only a greater or less portion of these elements are observed.

24. Can rules universally applicable be laid down for the Verification of Instruments and the Inspection of Meteorological Stations?

And is it advisable to introduce general instructions for taking and calculating Meteorological Observations?

The Congress considers the careful verification of all the instruments which are to be distributed to the Meteorological Stations, as well as the inspection of stations of the first and second order to be necessary, and the latter should take place if possible yearly, but at least once in the course of every five years.

The mode of verification of the instruments and of regular inspection is left to the decision of the Central Offices, and the Congress only expresses the wish that with regard to the instrumental errors which are thereby detected, corrected results only should be published, but that the amount of the corrections which have been applied should be given.

The Congress recommends the Permanent Committee, if possible by April 1874, to prepare Instructions for the institution and discussion of Meteorological Observations, to distribute them then in separate copies to all members of the Congress, and, subsequently, if possible, after paying all possible attention to the remarks which have been received, to proceed, at the latest in June, to edit and publish them definitively.

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25. In what manner can the agreement of the Standard Instruments of the different Central Establishments be best effected?

The Congress recommends all central offices to adopt real standard barometers, *i.e.*, instruments which allow of the determination of atmospheric pressure according to its definition in absolute measure. The Permanent Committee is commissioned to determine the conditions which such an instrument should fulfil.

At the same time the comparison by means of good portable barometers should not be rejected, and the Permanent Committee is instructed to investigate the best manner in which the comparison of the Standard barometers at the several central offices can be effected.

The Congress considers it to be the business of each central office to prepare a Standard thermometer for itself on scientific principles, and it recommends all central offices to forward all the Kew Standard thermometers, which they either already possess or will presently procure, to a gentleman to be indicated by the Permanent Committee, who shall be entrusted by it with the careful comparison of all these with each other, and, if possible, also with the air thermometer.

VI. Publication of the Observations.

26. Is it desirable and possible to publish the meteorological observations of a limited number of stations in each country in a uniform manner, and within a reasonably short time after the observations have been made?

Each director is to choose in his own district a number of stations for international objects and, for the publication of observations, is to adopt a common form (within the limits laid down by the hours of observation), which form is to be proposed by the Permanent Committee, after inquiry from the directors of the central offices.

27. How is the exchange of the meteorological publications of different institutions and different countries to be carried out most speedily, safely, and simply?

It is desirable, in order to facilitate the exchange of publications, to organise, on the model of the Smithsonian Institute at Washington, and the Central Bureau at Haarlem, a similar office in every country.

It is recommended to transmit smaller parcels by book post, and to send notice of the despatch, and receipts for the arrival, of the larger parcels.

VII. Carrying out the Decisions of the Congress.

28. What regulations should be adopted in order to carry into effect the decisions and the views of the Meteorological Congress?

Is the appointment of a Permanent Committee and the organisation of future Meteorological Congresses requisite for this purpose?

To express to the different Governments the wish that a new International Congress should be convoked in three years' time.

In the meantime to determine on the appointment of a Permanent Committee.

The Committee should consist of seven members chosen by the present Congress, and it has the power to fill up the places of members who resign, and eventually to increase itself by the co-option of two members at most.

The President shall also be chosen by the present Congress.

The Committee will have the duty of taking care for the carrying out of the decisions of the Congress, and of arranging for the convening of a future Congress; and it shall, by continual communications, place the delegates of the present Congress in cognisance of its action and proceedings.

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The Congress recommended the following rules for the extension of meteorological knowledge as desirable and very useful ;—

α. The establishment of permanent stations of observation on high mountain tops, if possible, provided also if possible with self-registering apparatus.

β. The institution of experiments on the possibility of making continuous meteorological observations with captive balloons.

γ. The institution of meteorological stations in the North Polar regions, and in high southern latitudes, the meteorological conditions of which are as yet either very slightly or not at all known, and in the first place at Spitzbergen.

δ. The institution of new supplementary stations on the north coast of Africa, as well as the regular publication of the observations which already exist on this coast.

ε. The more perfect organization of the stations in Turkey, and especially the central observatory at Constantinople, with regard to the advantage which is to be expected, both for science and navigation.

ξ. The maintenance of the meteorological station at Athens, and the publication of its observations.

29. M. Plantamour's proposal respecting the foundation of an International Central Institute for Meteorology?

1. The Congress holds the establishment of an International Institution for the advancement of meteorology as really useful and desirable.

2. The Congress furnishes the Permanent Committee with instructions to investigate all the questions bearing on the establishment of this Institution, and to propose a detailed scheme. The Committee should publish the result of its inquiry and proposals in the course of the year 1874, and should disseminate them as widely as possible, so that they can be taken into consideration by a future Meteorological Congress.

ADDITIONAL PROPOSALS.

Synchronous Observations.

It is desirable that, with a view to their exchange, at least *one* uniform observation of such character as to be suitable for the preparation of synoptic charts be taken and recorded daily and simultaneously at as many stations as practicable throughout the world.

Organization of a Meteorological System for China.

A report in favour of such a measure was adopted.

Proposal made by Professor Buys Ballot.

Should we not express the hope that an International Fund should be established, out of which observatories on islands, and at outlying localities, can be organized and maintained?

Referred to the Permanent Committee.

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Proposals made by Dr. C. Jelinek.

The Congress should take into consideration whether it would not be well to request the heads of the various systems of Meteorological observation to furnish reports, of as uniform a character as is possible, on the organization of their systems of observations, and especially of their Central Institution (if there be one), and on the condition of Meteorological investigations and publications, as well as on desirable developments and improvements. These reports should be collected and printed in a publication to be selected by the Congress.	Referred to the Permanent Committee.
The Congress should take into consideration whether it would not be well in the interest of facilitating Meteorological investigations to request the heads of the various systems of observation to state how many long-continued series of observations, printed or not, exist in their respective countries. In the case of printed observations the title of the publication (including publishers' name and the price) should be given, and in the case of unprinted ones the mode in which either extracts or copies can be procured. For the most important meteorological elements the mean values should be given, with indication of the years from which they have been deduced. The contents of these communications should be published by a special committee to be chosen by the Congress, and in a manner to be determined by that committee.	Referred to the Permanent Committee.

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ERRATA.

P. 22, line 7. *For* "$-0\cdot05$" *read* "$0\cdot65$.
line 16. *For* "syphon barometers" *read* "four syphon barometers."

P. 24, line 24. *For* "from the glass by louvres" *read* "by glass louvres."
line 5, from bottom. *For* "in the afternoon" *read* "at 8 or 10 p.m."

P. 37, line 17. *For* "syphon barometers" *read* "four syphon barometers."
line 25. *For* "from the glass by louvres" *read* "by glass louvres."
line 31. *For* "in the afternoon" *read* "at 8 or 10 p.m."

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REPORT

OF THE

PERMANENT COMMITTEE

OF THE

FIRST INTERNATIONAL CONGRESS AT VIENNA.

MEETING AT LONDON, 1876.

First Meeting, held 18th April 1876 at the Meteorological Office, at 11.15 a.m.

MEMBERS OF THE COMMITTEE PRESENT:

MM. Buys Ballot (President), Bruhns, Cantoni, Mohn, Scott, and Wild.

Mr. SCOTT was requested to continue to act as Secretary, which he expressed his willingness to do.

M. BUYS BALLOT, in opening the proceedings, welcomed the gentlemen who were present, and expressed his sincere regret at the absence of Dr. Jelinek, who was prevented attending the meeting by the state of his health.

The meeting then proceeded to construct, from the letters and communications which had been received from the members of the Committee and other gentlemen, a programme, which was adopted in the following form:—

I. Communications received. Replies to Circulars.
II. General Instructions for Observations.
III. International Telegraphic Code. Definition of Gradients.
IV. Synchronous Observations.
V. Forms of publication of Results for Stations of the First and of the Second Order.
VI. Report on Comparison of Standard Barometers and Thermometers.
VII. Inspection of Stations.

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VIII. International Investigations.
IX. Stations on mountains, distant islands, and in the Polar regions.
X. Preparations for the next Congress.
XI. Publication of the present proceedings.

I. Submitted—The following letters which had been received—

1875, May 20. Professor C. Piazzi Smith, respecting the scales to be used in Meteorology in future.

1876, February 7th and March 8th. Mr. H. B. Joyner, requesting the Committee to express their opinion of the importance of Meteorological Observations in Japan.

March 18th. Professor Buys Ballot, respecting the programme for the present meeting.

April 5. Dr. C. Jelinek, proposing various subjects for discussion at the present meeting, and at the coming Congress.

April 7th. Captain Hoffmeyer, respecting the Barometrical Gradients (p. 57).

April 13th. Captain Hoffmeyer, respecting the International Telegraphic Code (p. 57).

April 13th. Captain Hoffmeyer, proposing an International Exhibition of Instruments at the coming Congress (p. 58).

April 13th. Brig.-Gen. Meyer, conveying his congratulations to the Committee and his readiness to co-operate with them.

April 15th. Mr. A. Buchan, remonstrance against the action of the Committee (p. 54).

April 17th. Mr. W. Marriott, requesting the Committee to publish descriptions of the various types of instruments used in different countries (p. 58).

The following replies to Circular No. 3, Appendix I., were submitted—

* Scottish Meteorological Society, two letters.
M. Jelinek, Austria.
„ Hoffmeyer, Denmark.
„ Viñes, Havana.
„ Mohn, Norway.
„ Wild, Russia.
„ Wolf, Switzerland.
The Meteorological Society.
The Meteorological Office, accompanied by the Report of the Science Committee of the British Association.
MM. Bruhns, „ Schoder, „ Sohncke, } Germany.
Mr. Campbell, China.
MM. Buys Ballot.
„ Cantoni.

MM. Bruhns and Wild were requested to draw up a general summary of their contents.

* Neither of these letters contains any replies to Appendix E. of Report.

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The following replies to Circular No. 4 (Appendix II.) were submitted:—

MM. Lorenz, Vienna.
„ Bruhns, Leipzig.
„ Wild, St. Petersburg.
„ Coumbary, Constantinople.
„ Billwiller, (for Prof. Wolf) Zürich.
„ Cantoni, Pavia.
„ Ebermayer, Aschaffenburg.
„ Jelinek, Vienna.
„ Kingston, Toronto.
The Scottish Meteorological Society, Edinburgh.
The Meteorological Society, London.
The Meteorological Office, London.
M. Hoffmeyer, Copenhagen.
„ Aguilar, Madrid.
Mr. Stone, Cape Town.

Mr. SCOTT was requested to prepare a Report on these replies.

II. The next point on the programme was the possibility of the preparation of *General Instructions for Observations* as recommended by the last Report of the Permanent Committee, No. VIII., p. 8.

> "The Committee should institute a comparison between the Instructions which are to be prepared afresh by the individual Directors, and should point out those which in its opinion are most in accordance with the decisions of the Congress."

MM. CANTONI, MOHN, and WILD were requested to consider the existing forms of Instructions, of which the following were handed them, and, if possible, to prepare a Report thereon by Thursday the 20th inst.

The following Instructions were handed to the Sub-Committee:—

Austria - -	Dr. Jelinek.
England - -	Mr. Scott.
France - -	M. Marié Davy.
„ - -	M. Renou.
Germany - -	Professor Bruhns.
„ - -	„ Dove.
„ - -	„ Schoder.
„ - -	„ Sohncke.
Italy - -	„ Cantoni.
Norway - -	„ Mohn.
Russia - -	„ Wild.
Switzerland	The Swiss Meteorological Commission.
United States - -	„ General Myer.

III. *International Telegraphic Code and Definition of Gradients.*—M. WILD remarked that the existing difference in Wind Scales between the Telegraphic Weather Reports and

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ordinary observations caused errors, and asked if the Committee would recommend the discontinuance of the Beaufort Scale in the former.

The Committee decided that the proposed change did not seem advisable at present, and Mr. Wild determined to adhere to the Beaufort Scale in Telegraphic Reports, but to publish the wind velocity, in ordinary observations, as metres per second.

M. WILD proposed that M. Bruhns be requested to present to the next Congress a report on the present methods of reducing barometrical readings to sea level in different countries, and this proposal was accepted (p. 13).

The Committee expressed a hope that in all cases where the extreme difference of the corrections owing to temperature exceeded 0·1 mm., tables would be used instead of employing a constant correction.

A proposal of Capt. Hoffmeyer's (p. 57) to change the signification of the figure 7 in the weather scale from "Dust Haze" to "Aurora" was negatived.

A conversation arose as to the arrangement for conversion of a scale of 0—10, for the Amount of Cloud, to one of 0—4, required by the Code.

M. MOHN'S proposal for this was adopted :—

Observation.	Figure to be Telegraphed.
0—1	0
2—3	1
4—6	2
7—8	3
9—10	4

The proposal made by Captain HOFFMEYER for uniformity in the calculation of gradients (p. 57) was adopted in the following sense :—

The gradients for the Metric System to be calculated in millimetres per 1° of 60 nautical miles = 111 kilometres. For the British system they will be one hundredth of an inch (0·01) per 15 nautical miles.

A conversation arose as to the precise meaning of gradients, and it was arranged that the name of the station with higher pressure should stand first, and that the gradients should always be given as nearly as possible along the normals to the isobars.

The denomination is to be always the unit of the distance, the calculation of gradients with fixed numerator (as 1 inch in x miles) to be discontinued.

It is important that in Weather Telegraphy sufficient gradients be given to show the form of the depression.

IV. *Synchronous Observations.*—M. BUYS BALLOT stated that he had requested General Myer to publish three Synchronous Observations per day, and had proposed such a plan many years ago.

The Committee entirely approve of M. Jelinek's idea that more than one observation per day is required, but think that as a

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commencement the amount of international co-operation requested should be confined to one daily observation.

It was decided that the number of stations to be required and their distribution over the globe should be the same as that fixed for the International Stations of the Second Order. (Report of the Permanent Committee for 1874.) If, however, local circumstances allow of it, there is no objection to more observations being furnished.

Nations not taking part in this system as yet, are to be requested to join it.

The Committee have already expressed their opinion as to the necessity for their publication of these reports for Europe in their Circular No. 3 (Appendix I.).

The Committee have carefully considered the possibility of organising uniform hours for telegraphy for all Europe, as is the case in America, but they do not see how this can be effected unless the funds available for the service in each country be much increased, and the number of observations per day augmented. They do not see at present any probability of carrying this into effect.

The Committee then adjourned.

(Signed) BUYS BALLOT.

Second Meeting, April 19th, at 11.20 a.m.

PRESENT:

M. Buys Ballot (President), Bruhns, Cantoni, Mohn, Wild, and Scott (Sec.)

The minutes of the previous meeting were read and signed.

V. *Forms of Publication of Results for Stations of the First and of the Second Order.*—The question of publishing copies of hourly readings &c. for Stations of the First Order, was made the subject of serious discussion, and it was further resolved that the resolution of the Committee of September 12th, 1874, should be repeated and re-affirmed on the present occasion.

> "The observatories of the first order also should render their observations more generally available, by means of copying, and it seems desirable for the reduction of the term observations, and for the study of individual special phenomena of weather, that all observatories furnished with self-recording apparatus should reduce in extenso, and give hourly values of, the most important meteorological elements (for local time) for a number of years, and at the same time it is recommended that as regards humidity, not only the wet bulb thermometer should be given, but also, if possible, the calculated values of vapour tension and relative humidity."

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M. MOHN proposed that the Committee should express their approval of the publication of Hourly Readings which is conducted by the Meteorological Office, and their earnest hope that this might be continued.

This proposal was adopted.

M. BRUHNS asked if the arrangement of hours for stations of the second order could be made identical with those for telegraphic weather reports, but it was decided that, at present, perfect freedom must be allowed to each Director to arrange the hours of his system in the best manner possible to him. At the same time the very high importance of the proposal was admitted.

In reply to the observations in Mr. Buchan's letter of April 15th (Appendix IV.), on the part of the Scottish Meteorological Society, the Permanent Committee beg. to draw his attention to the fact that they have simply proposed the Forms to which he objects, but have no power or wish to enforce their acceptance.

Their Circular No. 4, of Feb. 19th, 1876, (App. II.), contains the following question:

1. "Do you approve of the forms recommended by the Permanent Committee for publication of the results from stations of the second order?"

This is a reference to the directors of the Forms in question with the view of eliciting their opinion on them, while they leave them free to accept them or the contrary. This action is entirely within the powers conferred on them by the remit from Vienna.

They would express their decided opinion that it would be most unwise to delay action on this head until the complete uniformity wished for as regards times, methods, and instruments is attained.

Mr. SCOTT submitted his Report on the replies to Circular IV. questions 1–3 relating to the Forms, App. II.

MM. BUYS BALLOT and CANTONI stated that they approved of the forms for International stations, reserving to themselves perfect freedom as regards all other stations, and as regards the possible republication of data from the International stations.

M. CANTONI inquired if the Committee approved of the International symbols for hydrometeors, but it was decided, that as these symbols had been adopted at Vienna, any question of possibly changing them must be referred to a new Congress.

It was explained, at his request, that the question of publications at monthly or yearly intervals was absolutely free, but that one month was the shortest period admissible.

M. CANTONI further requested the Committee to renew their recommendation of the third sitting at Utrecht, relative to the publication of Daily Weather Reports as follows:—

"In order to facilitate the study and examination of recent Weather Phenomena it would be very desirable if from the Central Offices of all great countries, or even according to the example given by Sweden, Norway, and Denmark in their 'Bulletin du Nord,' from the Central

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Offices of several countries together, *Daily Meteorological Bulletins* should be published, based on their Telegraphic Weather Reports, even if they are only copied on tracing paper, and without synoptic charts."

Mr. WILD proposed that the Committee should recommend the general adoption of the Meridian of Greenwich for tabular publication as well as for synoptic charts.

MM. BRUHNS and CANTONI considered that the question should be referred to the next Congress, while they fully agreed with the views expressed in the proposal.

It was finally resolved that this measure be recommended to the coming Congress for adoption (p. 13).

M. MOHN's proposal, as mentioned in Circular No. 3, was adopted as follows:

"With reference to the method of recording the epoch of the occurrence of rain, if the fall has occurred during the night, the letter *n* should be employed, instead of *a* or *p* as the case may be."

The Committee, after careful consideration of the proposal of Mr. Kingston (p. 52) do not see the possibility of introducing extra columns. The information desired by Mr. Kingston can be given in separate pages.

With regard to the proposal of the Meteorological Society (p. 53), they think that Absolute Humidity is more important than the Dew Point.

VI. M. WILD stated that the International Metric Committee in Paris would shortly be in possession of absolute standard instruments, and that subsequently all standard instruments in the world could be compared with these.

The PRESIDENT remarked that it would be advisable in the meantime, to effect an interchange between the principal observatories of instruments of the requisite accuracy of construction, and previously verified at the respective Central Offices, and that advantage should be taken of the coming Congress to convey instruments to the place where it should be held, for the purpose of comparisons; or, if it be not possible to transport them thither, that Leipzig should be selected as the central station for comparisons.

Directors are requested to give effect to this recommendation.

With reference to Thermometers, it was resolved to abide by the resolution at Utrecht:—

"M. BUYS BALLOT remarked that the comparison of the thermometers at one and the same central establishment was specially desirable. The Permanent Committee repeated their conviction of the urgent desirability of this comparison."

The Committee then adjourned.

(Signed) BUYS BALLOT.

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Third Meeting, April 20, 10.20 a.m.

PRESENT:

MM. Buys Ballot (President), Bruhns, Cantoni, Mohn, Scott, and Wild.

The Minutes of the previous meeting were read and confirmed.

VII. *Inspections of Stations.*—As it appears to the Committee from the answers to Circular 3 (App. I.) that although, in most of the systems, inspection is carried out, in others this measure is not yet carried into effect, it seems desirable to repeat the resolution of the Vienna Congress on this head (Appendix I. to Protocol of the Ninth Meeting):

> "The Congress considers the careful verification of all the instruments which are to be distributed to the Meteorological Stations, as well as the inspection of stations of the first and second order to be necessary, and the latter should take place, if possible, yearly, but at least once in the course of every five years"—

and to recommend it to the most serious notice of all institutions and organizations.

VIII. *International Investigations.*—In respect of this subject the Committee, after a careful consideration of the subject from various points of view, adopted the following resolutions:

1. Each Central Institute is to undertake the discussion of the Climatology of its own country, at its own expense, and to render the results accessible, distributing them to other institutions by way of exchange, and publishing them through a bookseller.

2. It does not seem possible to hand over the general treatment of one or more elements, for considerable portions of the globe, so as to deduce general laws, to an international institute which has yet to be called into existence, and it therefore appears best to distribute international investigations of this nature among the different countries by means of the individual Central Institutes. Each country which undertakes an investigation shall be charged with the cost of discussion, publication, and distribution of the results as above indicated.

3. M. BUYS BALLOT informed the Committee that the Royal Meteorological Institute of Utrecht and the Deutsche Seewarte had made arrangements for a mutual interchange of materials for certain parts of the ocean. The former will take up the China Seas (between 0° and 30° N. lat., the coast, and 150° E. long.), while the latter takes the area of the North Atlantic (between 30° and 50° N. lat. and from coast to coast.) The Institutes will supply each other with the entire material in their respective possessions for the districts in question, arranged in squares of one degree.

Mr. SCOTT drew the attention of the Committee to the questions of the international prosecution of Maritime Meteorology,

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and stated that in his opinion the mutual intercommunication of materials for such investigations could only be carried into effect where there was a reasonable reciprocity in the exchange, as the cost of correcting and copying the original observations—operations preliminary to any discussion—was exceedingly heavy.

The Committee expressed their hope that in the case of exchange of materials, a reciprocity between the different nations would be established, except as regards unavoidable expenses.

4. The enumeration of International investigations given by Dr. Jelinek in his letter (p. 2).

a. Tables for the Diurnal March of Temperature.
b. Monthly and Annual Temperature Tables (Celsius).
c. Rain Tables.
d. Barometrical Pressure Tables.
e. Monthly Isotherms for individual Years.
f. „ Rain Charts. „ „
g. „ Storm Tracks.

10. Experiments on Hygrometrical questions in India belongs properly to the Programme for the next Congress.

With regard to M. Hoffmeyer's charts, Mr. MOHN made, on the part of that gentleman, a statement to the effect that he did not wish for pecuniary contributions, except in the form of subscriptions to the Atlas.

The Committee considered that, as M. Hoffmeyer's International charts were already in course of publication, they ought to express the hope that he would be able to continue them until the next Congress, and they were very glad to hear that he had extended them to the Atlantic Ocean.

The following promises of subscriptions for the second year of the charts have been received:—

Austria	Dr. Jelinek	40
„	Dr. Lorenz	4
Bavaria.	M. Ebermayer	1
Canada	Dr. Kingston	10
Denmark	The Danish Institute	15
England	The Meteorological Committee	50
Hamburg	The Deutsche Seewarte	15
Holland	Professor Buys Ballot	3
Italy	M. Cantoni	12
Norway	Professor Mohn	10
Russia	Professor Wild	30
Saxony	Dr. Bruhns	6
Spain	M. Aguilar	1
Switzerland	Professor Wolf	6
Turkey	M. Coumbary	2
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The Committee then adjourned.

(Signed.) BUYS BALLOT.

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Fourth Meeting, April 21st, 10.30 a.m.

PRESENT:

M. Buys Ballot (President), Bruhns, Cantoni, Mohn, Scott, and Wild.

The Minutes of the last meeting were read and confirmed.

IX. *a. Mountain Stations.*—With reference to the resolution of the Vienna Congress VII. 28 *a*

The Committee expressed their recognition of the fact that stations at high levels have already been established in the following countries :—

France.	Pic du Midi and Puy de Dome;
Italy.	Stelvio and Col di Valdobbio.
Switzerland.	Great St. Bernard, Bernina, St. Gothard, Juliers, Simplon and Bernhardin;
Austria.	Hoch Obir, and Fleuss Goldzeche and Fleuss Zirmseehöhe;
United States.	Mount Washington, Pike's Peak, &c.;

and expressed their hope that other stations would be established in other similar localities, especially wherever isolated hills are to be found as *e. g.*, the Donnersberg in the Palatinate, the Faulhorn in Switzerland, &c. &c.

M. BUYS BALLOT expressed his hope that at such stations particular attention would be paid to Radiation.

b. In relation to Captive Balloons, BUYS BALLOT stated that M. Baumhauer's instruments had been, and still were being, improved for use under such circumstances, and the Committee expressed their sense of the value of such methods of observation for inaccessible stations.

It was resolved that the subject should be brought to the notice of the several Aeronautical Societies.

c. Distant Stations. A letter was read from M. Joyner at Japan, relative to the system of observations recently organised by the Japanese Government at Tokei, and M. BUYS BALLOT mentioned that a station had been organised by Dr. Geerts at Kioto, both stations having self-recording apparatus.

The Committee expressed its sincere hope that the Japanese Government will continue the Meteorological station which has been established under its auspices at Tokei, and will also support the station recently established at Kioto.

The individual Members will request their respective Governments to communicate this resolution to the Government in question through their diplomatic Representatives in Japan.

The Committee expressed the hope that all observations of reasonably high quality from distant islands, &c. should be published, even if they were only of short duration, and Mr. Scott was especially requested to publish any observations of that nature existing in his office.

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The Committee expressed their appreciation of the efforts successfully made to establish stations in Greenland, Iceland, and Labrador, &c.

The Committee further expressed their sense of the very high value which observations would have if they could be obtained from the islands in the Pacific, as they were not aware of any existing station situated within the limits of that ocean with the exception of those in New Zealand and the Philippines. They would remark that observations from *any* island will be of value.

The Committee, some members of which have become acquainted with M. Weyprecht's proposal to establish a number of observations in the Arctic Regions in order to secure simultaneous hourly observations in Meteorology and Terrestrial Magnetism around the Pole for at least one year, is of opinion that it should express its conviction that such observations would be of the greatest value for the progress of both Sciences, and recommends most warmly to all countries that they should, in the interest of Science, support and take part in such an undertaking.

In addition to any observing stations which may have been, or are now in operation, the Committee would especially direct attention to—

Spitzbergen;	Point Barrow;
Alten in Finmark;	Boothia Felix;
The mouth of the Lena;	Upernavik;
New Siberia;	Pendulum Island;

and will submit further particulars to the coming Congress.

The Committee was then adjourned.

(Signed) BUYS BALLOT.

Fifth Meeting, April 22nd, 10.30 a.m.

PRESENT:

MM. Buys Ballot (President), Bruhns, Cantoni, Mohn, Scott, and Wild.

The Minutes of the last meeting were read and signed.

MM. BRUHNS and WILD submitted their Report on the replies to Circular III., which was ordered to be printed. App. I.

MM. CANTONI, MOHN, and WILD stated, with regard to the form of Instructions, that of the Instructions which had been examined by them, those recently issued were on the whole conformable to the requirements of a General Instruction, when the Supplementary Instructions which had been drawn up in some cases, were taken into consideration, but that MM. Scott and Wild had prepared special instructions in English, and in German and Russian respectively, in accordance with the requirements of the Vienna Congress, while M. Cantoni had undertaken to revise his Instructions in Italian, so as to render them more conformable to those requirements than was the case with the present Italian Instructions.

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It was resolved that the Committee should express its hope that Instructions in the French language would shortly be prepared and published, which should be, as far as possible, in accordance with the requirements in question.

The Committee expressed its opinion that it is entirely impossible to devise a general form of Instructions which should be suitable, in all details, to the requirements of different countries and climates.

M. BUYS BALLOT pointed out especially that the hours of observation should never be changed without instituting a systematic comparison between the results obtained by the old and new systems of observations.

X. *New Congress.*—The PRESIDENT stated that he had learnt that the Italian Government was prepared to issue invitations for the next Congress.

M. CANTONI read an official letter which he had received on the subject from the Minister of Agriculture and Commerce of Italy, in which that Officer stated that if, as there are some reasons for supposing, the Permanent Committee would propose that the next International Meteorological Congress should be held at Rome, during the month of September 1877, the Italian Government would gladly welcome the proposal.

The Committee begged M. Cantoni to convey to the Italian Government their most sincere thanks for the intention, which has been expressed in the above letter, of issuing invitations for the Second Meteorological Congress to be held at Rome, and would venture to propose the 20th of that month as the first day of the meeting.

With reference to the preparations to be made for the Congress:—

1°. *Order of the Day.*—M. Bruhns agreed to prepare the Order of the Day by September 1st, 1876.

As regards Reports to be drawn up, all such are to be distributed in MS. to the Members of the Permanent Committee by the respective Authors, who as soon as they receive the replies, shall submit the definitive Report, with a copy of all replies, to the Secretary for the information of the Permanent Committee.

2°. *Report on the Action of the Committee.*—To be prepared by the Secretary.

3°. *Programme of Proceedings.*— M. Wild was requested to prepare this programme by July 1st, 1876. The Secretary is then to print this and distribute copies to the gentlemen present at the Vienna Congress, with the request that they will furnish the Committee with their opinions thereupon, by September 1st, 1876, in order that M. Wild may then be able to prepare a definitive programme.

4°. *Weather Telegraphy.*
5°. *Maritime Meteorology.* } Mr. Scott was requested to draw up Reports on both these subjects.

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6°. *Conformity of Instruments, Methods, and Publications with the Requirements of the Vienna Congress.*—To be referred to M. Jelinek.

7°. *Reduction of Barometers to Sea Level.*—To be referred to M. Bruhns as already determined, p. 4.

8°. *Reduction of Means obtained from various Hourly Combinations to True Means.*—To be referred to M. Buys Ballot.

9°. *Evaporation.*—To be referred to M. Cantoni.

10°. *Methods of determining the Fixed Points on the Thermometer Scale.*—M. Wild was requested to ask M. Pernet to prepare a report on this point.

11°. *Anemometers.*—MM. Scott and Wild were requested to obtain reports on this subject.

12°. *The choice of a Meridian for Charts.*—To be referred to M. Bruhns (p. 7).

13°. *Rain Gauges.*—To be referred to M. Mohn.

14°. *Humidity.*—To be referred to M. Cantoni.

15°. *Mountain Stations and Observations in Balloons.*—To be referred to Dr. Hann.

16°. *Distant Stations and Weyprecht's Proposal.*—To be referred to Professor Mohn.

17°. *Simultaneous Observations.*—To be referred to General Myer.

18°. *Synoptic Charts.*—To be referred to Captain Hoffmeyer.

19°. *Atmospheric Electricity.*—MM. Everett and Sohncke are to be requested to prepare reports on this subject. M. Cantoni also undertakes to furnish for these reports a resumé of the observations made for several years past in Italy.

20°. *Terrestrial Magnetism.*—Mr. Whipple to be requested to prepare a report on this subject. M. Wild also undertook to draw up a report thereon.

XI. It was resolved that the report of the present meeting should be published in three languages. The individual members present were requested to send in any additions they may have to make to the MS. Minutes to the Secretary within three weeks.

The Secretary then to proceed with the publication.

The several editions to be entrusted to the same gentlemen as before, viz., the French, to M. Buys Ballot; the German, to M. Bruhns, and the English to Mr. Scott.

The Committee expressed their thanks to the Meteorological Committee and to Mr. Scott for the reception which had been given to them, and they requested Mr. Scott to convey these thanks to the Committee.

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The PRESIDENT expressed his extreme satisfaction at the course the discussions had taken, and his thanks to the Members for their assistance in the general proceedings of the meeting, and coupled these thanks with the hope that they would all meet again at Rome.

The meeting was then adjourned at 2.15 p.m.

(Signed) BUYS BALLOT
C. BRUHNS.
G. CANTONI.
H. MOHN.
ROBERT H. SCOTT.
H. WILD.

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APPENDIX.

APPENDIX I.

Meteorological Office, 116, Victoria Street, London, S.W.,
May 5th, 1875.

SIR,

ON the part of the Permanent Committee of the Meteorological Congress at Vienna we beg to express regret that various circumstances have delayed the appearance of the French edition of the protocols at Vienna and Utrecht.

The German and English editions are already published, and a copy of one or other of them has, we doubt not, already reached you.

In the appendices you will find certain notes and suggestions with which the Committee have been favoured by various meteorologists of eminence, and furthermore some regulations which the Committee have thought fit to propose, with certain questions which they have ventured to ask.

The forms for the uniform publication of results from stations of the second order (as suggested by M. Wild, at Vienna) have been drawn up by MM. Wild and Jelinek, and accepted by the Committee.

You are requested to state whether you have any objection to use these forms for printing your observations, at least for the number of stations indicated by the Committee, according to the area of your district.

With reference to the method of recording the epoch of occurrence of rain, Professor Mohn has requested us to bring forward a proposition of his to the effect that, if the fall has occurred during the night, the letter *n* should be employed, instead of *a* or *p*, as the case may be.

It was the intention of the Committee to print the simultaneous observations made in Europe, Asia, &c. synchronous with $0^h\ 43^m$ Greenwich M. T. (corresponding to the time of the earliest observations made in the United States, viz., $7^h\ 35^m$ a.m. Washington M.T.) in compliance with the wish of Brigadier-General A. J. Myer, chief signal officer, U.S.A. Inasmuch, however, as that distinguished and zealous officer has taken on himself the labour and expense of printing and distributing these European observations as he already does with the American, it seems unnecessary to print them again, and more particularly so because M. Wild, for Russia, and M. Cantoni, for Italy, will print these observations for their own districts, and request you to do so for yours.

You will find in the Appendices certain Circulars, Appendix E and Appendix I, to which you are requested to furnish replies at your early convenience.

Of the contents of these circulars the Committee would specially draw your attention to the request for a list of all the unpublished observations, either of ancient or modern date, which are in your possession, with a statement of where they are to be found, and on what conditions they can be inspected and copies of them obtained. (*See Appendix.*)

You will at once admit that it is important to collect these valuable materials for various objects, particularly for the purpose of determining the average height of the barometer and thermometer at distant stations, and from old series of observations, and also that the corrections for your combinations of hours for deducing the true mean temperature of the day may be found, in order to reduce the synchronous observations to that value, and make them intelligible and useful.

It is also very desirable that at certain places, where such extensive libraries as those at St. Petersburg, Vienna, &c., do not exist, a copy of these observations and printed works should be deposited, and in that respect M. Buys

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Ballot will feel deeply indebted to anyone who will kindly continue to furnish him with reports, publications, &c., of this nature as on former occasions.

You will receive a list of distant stations where observations have been made since the date of the Congress at Vienna.

If you will have the kindness to state what distant stations have been established through your influence you will certainly be carrying out the wishes expressed at that meeting.

The Committee will be especially pleased to learn your opinions on any point of international meteorology, and to be informed of any point which may appear to you to be advisable to be taken into consideration, or to be treated in a different manner from that which has hitherto been the case.

BUYS BALLOT, *President*
ROBERT H. SCOTT, *Secretary*.

Appendix.

The following *ad interim* replies have already been received to Circular I:—

Professor Buys Ballot reports that he has, at Utrecht, hourly observations of wind, temperature, and barometer, for the Helder, Groningen, and Utrecht, and that the series for Flushing is to commence May 1875.

Furthermore, he has continuous photographic records from the magnetographs at Utrecht.

Professor Bruhns reports that he has at Leipzig—

(1.) Observations of temperature, pressure, wind and cloud, at Leipzig three times daily (1830–60.) [Results printed in the second volume of "Resultate aus meteorologischen Beobachtungen in Sachsen." Leipzig, 1867.]

(2.) Observations of a similar character from Dresden, 1847–68. Results in first volume of above publication.]

(3.) Observations of a similar character from Oberwiesenthal, 1858–63. [Results in first volume as above.]

(4.) At Freiberg there are observations of pressure, temperature, the minimum thermometer, the fall of rain, &c., and the wind, daily, in part twice, in part only once, by Ober-bergrath Reich 1830–64. [Results in third volume as above.]

Mr Scott reports that the information as regards the observations in the British Isles and the Colonies is already in print, in the report of the Committee of the British Association on Science Lectures and Organisation. Report British Association, 1873, pp. 495–522.

APPENDIX E. to the Report for 1874.

(A.) *Questions relating to the Central Institution.*

1°. Are the details of the organisation of your system of observations published, and if so, in what work?

2°. When was your Central Institution established?

3°. Does it include several departments, and if so, for what lines of action? Is there a Magnetical Observatory connected with your establishment.

4°. Is the financial estimate of your institution published, and if so, where?

5°. Are Weather Reports regularly sent to your Central Institution, and if so, from how many inland as well as foreign stations? In what way are these telegraphic reports worked up? Are the weather bulletins published in the daily newspapers, and by which?

6°. Do the stations of your system take part in the scheme of synchronous observations initiated by General A. J. Myer, and which are these stations?

7°. In what manner are the barometer observations reduced to sea level?

8°. What improvements and extensions in the organisation of your system of observations do you consider necessary, or desirable.

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(B.) *Questions relating to the Stations.*

1°. What elements are included in the observations at most of your stations?

2°. Are there several classes of stations, according to the definition of the Vienna Congress? (IX. Meeting, App. I.) Are there special stations for the calculation of rainfall, and others for the investigation of the tracks of thunderstorms, and the distribution of hail?

3°. What is the number of stations in each class?

4°. Are the stations regularly inspected, and at what periods on an average?

5°. Is a description of the instruments used at the stations of your system published, and if so, in what work?

6°. (*a.*) What kind of barometers are used at your stations? Syphon barometers, fitted with or without microscopes, barometers on Fortin's principle, or such cistern barometers in which a change of level of the cisterns is provided for in the scale (as in Adie's barometers), or by calculation (as in Kappeller's barometers). Are Aneroid barometers used for the observations?

(*b.*) What is the average error in a comparison of your barometers with the normal barometer? What is the average constant difference between the station barometers and the normal barometer?

(*c.*) From what maker do you get the station barometers, and what is their usual price?

7°. What kind of thermometers are used at your stations?

(*a.*) Are your thermometer bulbs spherical or cylindrical?

(*b.*) Are the thermometers graduated on the stem or provided with a special scale?

(*c.*) What is the exposure of the thermometers? are they placed outside a window, or in the free air, in the shade of the house, or over an open grass-plot?

(*d.*) What kind of screen is used for your thermometers, and especially of what material? Are they fixed or moveable, according to the sun's position? are they protected from terrestrial radiation?

(*e.*) At what height above the ground are the thermometers placed?

(*f.*) Is an arrangement for ventilation used for the thermometers? Is the rotatory thermometer used?

(*g.*) Whence are the thermometers obtained, and what is their price?

8° Are maximum and minimum thermometers used at your stations, and on what principles? By whom are they made, and what is their price?

When are the maximum and minimum thermometers read?

9°. (*a.*) What is the construction of your rain-gauges? Of what material are they made?

(*b.*) What size is the receiver of the rain-gauges at your stations? Is it circular or square?

(*c.*) At what height above the ground is the receiver of your rain-gauges?

(*d.*) What is the price of such a rain gauge, including the measuring glass?

(*e.*) What method is used in measuring snow?

(*f.*) At what time of the day is the fall measured?

10°. Do the stations possess a special wind-vane for recording the direction of wind, or are the observations made by the vanes on steeples, or from the direction of smoke, &c.?

11°. Is the wind force estimated, and by what scale? Or do you make use of simple dial instruments (Robinson's anemometers), or vanes with pendulum-like wind-gauges (Wild's or Prestel's anemometers)?

12°. Is the amount of evaporation measured at any of your stations, and by means of what apparatus? What is the extent of the evaporating surface? Is the atmometer protected from sun and rain, or is the evaporation measured on an open surface of water?

The above questions by no means exhaust all the circumstances to be considered in the establishment of a Meteorological system, but they contain the principal points, and the Permanent Committee do not wish to take up too much of your time and trouble in answering a too comprehensive series of questions.

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Summary of Replies to Circular E., Report of the Utrecht Meeting, p. 45.

A.—Questions relating to the Central Institution.

1°. *Are the details of the organisation of your system of observations published, and if so, in what work?*

The Meteorological Society of London.—The details of organisation are published in the Report of the Council read at the Annual General Meeting, January 19th, 1876.

The Meteorological Office, London.—The details are published in the Annual Reports of the Office, and also in a memorandum on the organisation of the Office. (Not reprinted here.)

Norway.—Published in the Jahrbuch of the Norwegian Meteorological Institute, and also in "Ocean Highways," vol. I. new series, pp. 12, 157.

Saxony.—Published in the first vol. of "Resultate aus den meteorologischen Beobachtungen," Leipzig, 1865.

Baden.—Published in the first "Jahresbericht der Central-Station, Carlruhe, 1869, by Dr. Weber, Carlsruhe, 1870.

Bavaria.—No reply (see p. 52).

Würtemberg.—No reply.

Russia.—Published in the "Jahresbericht des Central Observatoriums."

Denmark.—Published in the Annuaire de l'Institut Danois pour l'année 1874.

Holland.—Details not published.

Italy. — Details not published in full, some particulars are given in the Supplement to "Meteorologia Italiana," for 1873?

Cape Colony.—Details given in subjoined letter, p. 56.

2°. *When was your Central Institution established?*

Meteorological Office, London.—For Maritime Meteorology 1854. Extended to the Land Meteorology of the United Kingdom 1867.

Norway.—In December 1866.

Saxony.—In December 1863.

Würtemberg.—In 1874.

Baden.—In the autumn of 1868.

Russia.—In 1849. Remodelled 1872.

Denmark.—In 1872.

Holland.—Privately in 1849. Officially 1854.

Italy.—The Bulletin, Meteorologia Italiana was founded in 1864 by the Ministry of Agriculture and Commerce.

Cape Colony.—The Meteorological Commission was established in 1867; reconstituted 1874.

3°. *Does it include several departments, and if so, for what lines of action? Is there a magnetical observatory connected with your establishment?*

Meteorological Office, London.—Three departments: *a.* Ocean Meteorology, *b.* Weather Telegraphy, *c.* Land Meteorology of the British Isles. The Magnetic Observatory at Kew is independent of the Meteorological Office.

Norway.—One department for Land Meteorology. Observations made at sea are collected; but are hardly discussed at all.

Saxony.—One department for Land Meteorology.

Baden.—Ditto.

Würtemberg.—Ditto.

Russia.—Four departments: *a.* Land Meteorology, *b.* Ocean Meteorology, *c.* Weather Telegraphy, *d.* Terrestrial Physics. A magnetic observatory belongs to department *d.*

Denmark. — Two departments: *a.* Land Meteorology, *b.* Telegraphy and Hydrography (Sea surface temperature, &c.).

Holland.—Two departments: *a.* Land Meteorology, *b.* Ocean Meteorology. There is a magnetic observatory, the constants are determined absolutely twice a month, the Declination is the only element recorded photographically.

Italy.—Two departments. The Office which publishes the "Meteorologia Italiana," is quite distinct from that which is charged with Weather Telegraphy. This latter is under the Marine Ministry.

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4°. *Is the financial estimate of your Institution published, and if so, where?*

METEOROLOGICAL OFFICE, LONDON.—In the Annual Reports of the Office and in the memorandum already mentioned. The Annual grant is 10,000*l.*

NORWAY.—In "Ocean Highways," *loc. cit.*

SAXONY.—Not published. It is about 600*l.*

WÜRTEMBERG.—Not published. It is about 225*l.* exclusive of cost of printing.

BADEN.—Not published.

RUSSIA.—Not published. It is about 59,000 roubles (9000*l.*?).

DENMARK.—Not published. It is about 860*l.*

HOLLAND.—Not published. It is about 8,700*l.*

ITALY.—Not published.

5°. *Are Weather Reports regularly sent to your central institution, and if so from how many inland as well as foreign stations? In what way are these telegraphic reports worked up? Are the Weather Bulletins published in the daily newspapers, and by which?*

METEOROLOGICAL OFFICE, LONDON.—Yes, from 29 home, and 22 foreign stations. The method of treatment of the Reports is given in the memorandum. The Reports are published as Daily Weather Reports, and in the newspapers.

NORWAY.—Yes, from 7 home, and 10 foreign stations. A daily bulletin with a chart is posted up, and an abridged bulletin is given in the newspapers. The same method is followed with Storm Warnings. The complete publication for Norway, Sweden, and Denmark is in the "Bulletin du Nord."

SAXONY.—No, the central office for Weather Telegraphy in Germany is the Deutsche Seewarte at Hamburg.

BADEN.—Ditto ditto ditto.

WÜRTEMBERG.—Ditto ditto ditto.

RUSSIA.—Yes, from 45 home, and 24 foreign stations. A bulletin, without a chart, is published daily, and appears in several newspapers. Storm Warnings are issued.

DENMARK.—Yes, from 8 home, and 19 foreign stations.

HOLLAND.—Yes, from 4 home, and 14 foreign stations. The results of discussion of the telegrams are posted up in the harbours and printed in the newspapers. The Aeroklinoscope announces the conditions of the atmosphere by signal.

ITALY.—The Ministry of Agriculture receives each decade the daily reports from 24 Meteorological stations.

6°. *Do the stations of your system take part in the scheme of synchronous observations initiated by General A. J. Myer, and which are these stations?*

METEOROLOGICAL OFFICE, LONDON.—Yes, the number of stations exceeds 60. The names are given in the Annual Reports of the Meteorological Office, and in General Myer's "Bulletins of the War Department."

NORWAY.—Yes. *See* Myer's Bulletin.

SAXONY.—Ditto ditto ditto.

WÜRTEMBERG.—Ditto ditto ditto.

BADEN.—Ditto ditto ditto.

RUSSIA.—Ditto ditto ditto.

DENMARK.—Ditto ditto ditto.

HOLLAND.—Yes, from 4 stations. *See* Myer's Bulletins.

ITALY.—Yes, more than 30 stations take the synchronous observations, of which more than 20 are sent to General Myer each decade.

7°. *In what manner are the barometrical readings reduced to sea level?*

METEOROLOGICAL SOCIETY, LONDON.—By the tables in "Instructions in the use of Meteorological Instruments" by R. H. Scott, F.R.S. Special tables are prepared for each station, taking into consideration index error, temperature, and elevation. Mr. Marriott has explained these tables. (Quart. Journ. Met. Soc., January 1876.)

METEOROLOGICAL OFFICE, LONDON.—By the tables in the "Instructions" above mentioned. Cards are prepared, combining for each station index error, and correction for height.

NORWAY.—By tables specially constructed, taking into consideration pressure and temperature.

SAXONY.—By the strict formula, taking into consideration pressure and temperature.

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WÜRTEMBERG.—By the strict formula.
BADEN.—By the strict formula, the constants being taken from Jordan's Notiz-kalender.
RUSSIA.—By the strict formula, taking into consideration pressure and temperature.
DENMARK.—By the application of a constant correction, as no station is at a higher level than 160 feet above sea level.
HOLLAND.—Ditto ditto ditto.
ITALY.—The reduction is made by the tables published by the Ministry of Agriculture, which take into consideration pressure and temperature.

8°. *What improvements and extensions in the organisation of your system of observations do you consider necessary or desirable?*

METEOROLOGICAL OFFICE, LONDON.—The question of the future improvement of the system of the Meteorological Office is under consideration by a Committee appointed by the Government.
NORWAY.—An office in the town and an observatory outside it. A department for Maritime Meteorology: the development and extension of Storm Warnings. Observatories on the West Coast and in Arctic Norway.
SAXONY.—Fusion of the German systems under one head, and issue of *one* German publication.
BADEN.—Observations on Evaporation and Earth Temperature, self-recording observations.
RUSSIA.—A department for Agricultural and Forest Meteorology.
HOLLAND.—We are endeavouring to have the readings of the barometer at the principal stations recorded at Utrecht.
ITALY.—Explained in the Report of the Meteorological Congress at Palermo, September 1875.

B.—QUESTIONS RELATING to the STATIONS.

1°. *What elements are included in the observations at most of your stations?*

METEOROLOGICAL SOCIETY, LONDON.—Pressure, temperature, humidity, wind, clouds, rain and hydrometeors.
METEOROLOGICAL OFFICE, LONDON.—Ditto. ditto. ditto.
NORWAY.—The usual elements.
SAXONY.—Ditto.
WÜRTEMBERG.—Ditto.
BADEN.—Ditto.
RUSSIA.—Ditto, with evaporation.
DENMARK.—Ditto.
HOLLAND.—Ditto, and atmospheric electricity, with Peltier's apparatus, at Utrecht and Helder.
ITALY.—Most of our stations have barometers, thermometers (max. and min.), dry and wet bulb thermometers (the latter with arrangements for ventilation), rain-gauges, atmometers, anemoscopes; several have also anemometers, Palmieri's electrometers, and a few are provided with magnetic and seismographic apparatus.

2°. *Are there several classes of stations according to the definition of the Vienna Congress? Are there special stations for the calculation of rainfall, and others for the investigation of the tracks of thunderstorms and the distribution of hail?*

3°. *What is the number of stations in each class?*

METEOROLOGICAL SOCIETY, LONDON.—Yes. 18 stations of the second order, 15 of the third order.
METEOROLOGICAL OFFICE, LONDON.—Yes. 7 stations of the first, 17 of the second, and 17 of the third order. There are about 1,600 rainfall stations under Mr. Symons. No stations for thunderstorms or hail.
NORWAY.—32 stations of second order, 10 of the third, 150 for thunderstorms.
SAXONY.—1 of first order, 19 of second, 5 of third, with some rainfall stations, but none for hail or thunderstorms.
WÜRTEMBERG.—14 of second order, 7 of third.
BADEN.—12 of second order, 4 of third, and 1 rainfall station.
RUSSIA.—1 central observatory, 6 stations of the first order, 118 of the second, about 220 for rain, and 350 for thunderstorms.

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DENMARK.—1 station of first order, 15 of second, 60 of third, 71 for rain, 25 for wind, four for hydrography.

HOLLAND.—3 stations of first order, four of second, two of third, and one of fourth. There are 30 extra rainfall stations.

ITALY.—Yes. The Meteorological Commission is now arranging the number of stations of each order. I may say that we shall have in Italy at least 30 good stations of the second order.

4°. *Are the stations regularly inspected, and at what periods on an average?*

METEOROLOGICAL SOCIETY, LONDON.—Yes. The stations of the second order when first established, and subsequently at irregular intervals.

METEOROLOGICAL OFFICE, LONDON.—Annually.

NORWAY.—Biennially or quadrennially.

SAXONY.—Annually; some twice a year.

WÜRTEMBERG.—Annually; some twice a year. The stations of the third order occasionally.

BADEN.—Annually.

RUSSIA.—Undecided.

DENMARK.—The stations of first and second order annually, except those in Greenland; the other stations are only partly inspected every year.

HOLLAND.—A general inspection is made every three years. The stations are occasionally inspected at irregular intervals.

ITALY.—The Meteorological Commission has recommended that all stations of the second order should be inspected annually, or at least every two years.

5°. *Is a description of the instruments used at your stations published, and if so, in what work?*

METEOROLOGICAL SOCIETY, LONDON.—Yes, in the Optician's Catalogues.

METEOROLOGICAL OFFICE, LONDON.—The self-registering instruments are described in the Annual Reports for 1867 and 1869. The instruments for eye observations are described in the "Instructions."

NORWAY.—The new arrangements introduced in 1875 are not yet described.

SAXONY.—Published in the first volume of Results.

BADEN.—Described in the Swiss Instructions and the first volume of the Baden Observations.

RUSSIA.—Partly in the first Instructions: "Repertorium Vol. I." The atmometer, syphon barometer, and wind pressure plate are described in the Bulletin of the St. Petersburg Academy. The new thermometer screens are not yet described.

DENMARK.—In the Annuaire for 1874.

HOLLAND.—In a publication by Dr. Krecke.

ITALY.—See "Norme per le Osservazione Meteoriche," published in 1875.

6°. *a. What kind of barometers are used at your stations? Syphon barometers, fitted with or without microscopes, barometers on Fortin's principle, or such cistern barometers in which a change of level of the cistern is provided for in the scale (as in Adie's barometers) or by calculation (as in Kappeller's barometers. Are aneroid barometers used for the observations?*

6. *b. What is the average error in a comparison of your barometer with the normal barometer? What is the average constant difference between the station barometers and the normal barometer?*

6. *c. From what maker do you get the station barometers, and what is their usual price?*

METEOROLOGICAL SOCIETY, LONDON. — *a.* Fortin's standards and Kew barometers.

b. From various makers.

METEOROLOGICAL OFFICE, LONDON.— *a.* The stations of the first order have Fortin's barometers, those of the second, Kew barometers. Aneroids are not used.

b. The limit of error in Kew barometers is 0·015 in. = 0·4 mm., and the correction for capacity is 0·004 in. = 0·1 mm.

For Standard barometers the limit of error of scale is 0·010 in. = 0·25 mm.

c. Barometers obtained from Adie, Pall Mall, London, the price is 3 10 0

Verification - - - - - - - 0 10 0

Total cost - £4 0 0

If 12 barometers be ordered the price is 3*l.* 5*s.*

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NORWAY.—*a.* 16 stations have Fortin's barometers.
16 „ Kew „
10 lighthouses and two other stations have only aneroids. All stations have aneroids as reserve instruments.

b. The mean error of Fortin's barometers is ± 0·45 mm.
„ „ Kew „ ± 0·45 „
The constant correction of the former is on the average —0·65 mm., of the latter —0·21 mm.

c. The former from Secretan in Paris and Olsen in Christiania, the latter from Adie in London. Price about 120 francs.

SAXONY.—*a.* One station has a Fortin's barometer, and one a Kew barometer, all the rest have syphon barometers with microscopes; as reserve instruments syphon barometers divided on the tube, and without microscopes, are employed and aneroid barometers.

b. Error of comparison with normal ±0·05 mm. with no constant difference between normal and standard barometer.

c. The first 20 station barometers were got from J. Greiner, Berlin, the later from Schadewell of Dresden. Prices 9*l.* and 6*l.*

WÜRTEMBERG.—*a.* Seven cistern barometers from Herman and Pfister of Berne, without microscope, but with vernier.
One syphon barometer by Kappeller of Vienna. The other stations have syphon barometers which will be replaced by cistern barometers. No aneroids.

c. The price of the cistern barometers, 7*l.*; of the syphon barometers, 3*l.* 8*s.*

BADEN.—*a.* Cistern barometer with vernier, but no microscope. No aneroids.

b. Difference between station barometer and standard barometer is —0·39 mm. The correction for capillarity agrees with that, and is +0·4.

c. Hermann and Pfister in Berne, price 3*l.* 8*s.* 0*d.*

RUSSIA.—*a.* Principally syphon barometers, mercury raised in both legs before reading, without a microscope.
Some have cistern barometers with large cisterns. Some have Fortin's pattern, some Parrott's (with a float on the outer surface of the mercury) especially in the Caucasus.
All new stations have aneroids as reserve instruments. Stations of 1st order and those of the Bureau of Mines have all of them two or three mercury barometers. Some distant and inaccessible stations have only aneroids, which are controlled by thermo-barometers.

b. Mean error of a comparison ±0·09 mm.; comparison with normal barometer ±0·04 mm.; constant corrections vary from 0 to ±·1 mm.

c. The new syphon barometers by Turrettini in Geneva, but filled by the workmen at the Observatory in St. Petersburg, verified and packed there, cost 256 francs.

DENMARK.—*a.* Mercurial barometers by Kappeller in Vienna, used in Denmark. Fortin's and Kew in the colonies.

b. Constant correction ·1 to ·2 mm.

c. Price of Kappeller's and Fortin's barometers 160 francs and Adie's (Kew) barometers 130 francs.

HOLLAND.—*a.* Syphon barometers and six cistern barometers. Aneroids never used. At some stations two barometers are always used.

b. The error of a comparison with proper care does not exceed 0·05 mm. The greatest correction is not ·3 mm.

ITALY.—*a.* Most stations have Fortin's or large syphon barometers. Aneroid observations never used.

b. In the supplement for 1875 a Paper by M. Denza on the comparison of a large number of our barometers will be printed.

c. Most instruments are furnished by the physical establishment, the Tecnomasio of Milan. Price of Fortin's, with large cistern, 4*l.*; of syphons, 5*l.*

7. *What kind of thermometers are used at your stations?*

a. Are your thermometer bulbs spherical or cylindrical?

b. Are the thermometers graduated on the stem, or provided with a special scale?

c. What is the exposure of the thermometers? Are they placed outside a window, or in the free air in the shade of the house, or over an open grass plot?

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d. What kind of screen is used for your thermometers, and especially of what material? Are they fixed or moveable according to the sun's position? Are they protected from terrestrial radiation?

e. At what height above the ground are the thermometers placed?

f. Is an arrangement for ventilation used for the thermometers? Is the rotatory thermometer used?

g. Whence are the thermometers obtained, and what is their price?

METEOROLOGICAL SOCIETY, LONDON.—*a.* Mostly spherical.

b. Graduated on the tubes.

c. In a screen on an open grass plot.

d. Stevenson's screen is fixed and protected from terrestrial radiation.

e. Four feet.

f. The screen has louvres for ventilation. The thermomètre fronde is not employed.

g. From different makers.

METEOROLOGICAL OFFICE, LONDON.—The thermometers are known as Kew thermometers.

a. Spherical bulbs.

b. Graduated on the stem.

c. and *d.* Wherever possible, in Stevenson's screens in which protection against radiation is provided. Where this is not possible wall screens are used. Thermographs are placed in wall screens.

e. Height of thermometers four feet.

f. No ventilation arrangements are employed, nor the thermomètre fronde.

g. Price of thermometers 5*s.*, verification 1*s.*, furnished by—

Casella, Holborn Bars.
Hicks, Hatton Garden.
Negretti and Zambra, Holborn Viaduct.
Pastorelli, Piccadilly.

NORWAY.—*a.* Spherical.

b. Paper scales to $\frac{1}{5}$° c. sealed hermetically in the tube.

c. and *d.* At windows with sheet iron screens louvred outside, open on the side of the window and below. The screens are protected by other screens against the sun, so that the instruments are kept in the shade at least two hours before the observation.

e. Height varies from 0·9 to 13·1 m., average 2·3 metres.

f. No.

g. From Odermann in Stockholm for 9*s.*

SAXONY.—Mercurial thermometers are used at all stations.

a. Spherical.

b. Scales on enamelled glass, fastened in.

c. Erected before the windows.

d. Placed in moveable zinc screens partly with double sides, no protection below.

e. 4 m. on the average, varies between 2 & 9.

f. No arrangement for ventilation or thermomètre fronde.

g. The first thermometers from Greiner of Berlin, the latter from Leyser of Leipzig. Price 24*s.* and 18*s.*

WÜRTEMBERG.—*a.* Spherical.

b. Scale on glass and enamelled glass, the 1st giving $\frac{1}{2}$° the latter 0·2°.

c. For the most part before windows.

d. Protection, wooden louvred screens, a comparison of temperatures taken in wooden and metal screens resulted in favour of the former.

e. Height varies between 3–10 m.

g. A thermometer to $\frac{1}{2}$° costs 8*s.* 6*d.*, to 0·2° costs 12*s.*

BADEN.—Celsius thermometers divided to $\frac{1}{5}$°.

a. Spherical.

b. Divided on separate scales.

c. At a window.

d. In metal screens with sides and roof pierced, if necessary wooden screens put up, no protection against terrestrial radiation.

e. Between 2–12 m.

f. No ventilation arrangement, no thermomètre fronde.

g. Hermann and Pfister of Berne. Price 13*s.* 6*d.*

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RUSSIA.—*a.* Spherical.
b. Scale on enamelled glass, divided into $\frac{1}{5}$° degree. The outer tube with brass fitting hermetically closed.
c and *d.* Metal screens with louvres constructed with 2 cylinders.
Partly placed 0·3 m. before a window on N. side and sheltered from the sun by a wooden screen; for the most part erected in wooden cases of 2 cb. m. open below and to the north, louvred side doubled on the south, louvres to E. and N. In the new screens radiation from below is cut off.
e. 2½–3 m., some stations higher.
f. No.
g. By Geissler at Bonn and verified by the workmen at the Observatory at St. Petersburg. Price 21*s.*
DENMARK.—*a.* Spherical.
b. Special scales.
c and *d.* Before a north window in wooden screens with double louvres, protected by special screens against the sun.
At stations of 1st and 2nd order the terrestrial radiation is stopped.
e. 1½ m.
f. No.
g. At Copenhagen for 30 francs.
HOLLAND.—Mercurial thermometers.
a. Spherical.
b. Graduated on the tube.
c. Outside the windows protected by glass louvres.
e. Height variable, 1–3 m.
f–g. Various makers and various prices.
ITALY.—*a.* Cylindrical bulbs, diameter small in proportion to their length.
b. Graduated on the stem.
c–d. Outside a north window, protected from radiation by louvres.
e. At different heights according to the condition of the building.
f. Thermometers are always ventilated by an arrangement fitted to the psychrometer.

8 *Are maximum and minimum thermometers used at your stations, and on what principles? By whom are they made and what is their price?*

When are the maximum and minimum thermometers read?

METEOROLOGICAL SOCIETY, LONDON.—Yes. Maximum on Negretti's and Phillips', minimum Rutherford's. Different makers. Read 9 p.m.

METEOROLOGICAL OFFICE, LONDON.—Minimum on Rutherford's, some with sensitive bulbs, maximum on Negretti's or Phillips', makers same as for ordinary thermometers. Contract price 18*s.* 6*d.*, verification 1*s.*

NORWAY.—Minimum divided for all degrees at all stations. Made by Grave at Stockholm. Price 5 crowns. There is a maximum thermometer at Christiania. The maximum is read in the evening and the minimum in the morning.

SAXONY.—Spirit minimums at all stations. Maximum thermometers with steel index at some. All the metallic maximums have become useless. The minimum thermometers by Greiner of Berlin cost 24*s.* Those of Leyser of Leipzig, 15*s.* The minimum read in the morning, maximum in the evening.

WÜRTEMBERG.—Maximum and minimum thermometers everywhere, the former do not always work well. Maximum cost 9*s.*, minimum 7*s.*

BADEN.—Mercurial maximum thermometer and alcohol minimum made by Greiner of Munich. Former costs 10*s.* 3*d.*, latter 9*s.* Read at 9 p.m.

RUSSIA.—Only spirit thermometers at all stations, divided to $\frac{1}{5}$ C., with forked bulb, by Geissler, of Bonn. Price 26 francs. Read at 9 p.m.

DENMARK.—The majority of stations have Phillip's maximum and Rutherford's minimum.

HOLLAND.—By Greiner, from Utrecht, and also by Negretti and Zambra, maximum and minimum, both read at 8 or 10 p.m., and at Utrecht in the morning also.

ITALY.—The two thermometers, maximum and minimum, are separated from each other. The maximum is mercurial and the minimum contains amylic alcohol. The former is read at 9 p.m., the latter at 9 a.m.

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9 (*a.*) *What is the construction of your rain-gauges? Of what material are they made?*

(*b.*) *What size is the receiver of the rain-gauges at your stations? Is it circular or square?*

(*c.*) *At what height above the ground is the receiver of your rain-gauges?*

(*d.*) *What is the price of such a rain-gauge, including the measuring glass?*

(*e.*) *What method is used in measuring snow?*

(*f.*) *At what time of the day is the fall measured?*

METEOROLOGICAL SOCIETY, LONDON.—(*a.*) Glaisher's and Symons' pattern, made of copper.
(*b.*) Diameter 8 and 5 inches. Circular.
(*c.*) 1 foot above ground.
(*e.*) Snow melted and water measured.
(*f.*) 9 a.m.

METEOROLOGICAL OFFICE, LONDON.—(*a.*) Glaisher's pattern, of copper, with snow cylinders.
(*b.*) Circular, 8 inches diameter.
(*c.*) Height 1 foot 9 inches.
(*d.*) Price 2*l.* 2*s.*
(*e.*) Snow melted.
(*f.*) 9 a.m., put down to previous day.

NORWAY.—(*a.*) (*b.*) (*c.*) Round vessels of zinc or tin of 1 Norwegian square foot or ·1 square metre. The new ones are square 0·15 m. a side, ½m. high. Height above ground varies from 0·4—4 metres, and even to 15m. on a roof. Average height 1·4m.
(*d.*) Price of latter sort 15 francs. Measuring tubes divided at Institute.
(*e.*) Snow melted.
(*f.*) Reading at daylight (in winter).

SAXONY.—(*a.*–*c.*) Rain-gauge of zinc, with strong brass ring, circular aperture, with area of 1,000 square cm., height 1½ metre above ground.
(*d.*) Rain-gauge has two vessels, and stand is made of iron. Price, with measuring tube, about 3*l.*
(*e.*) Thawed and measured.
(*f.*) Reading made early in the morning.

WÜRTEMBERG.—(*a.*) Tin.
(*b.*) Square. 1 square foot (Paris).
(*c.*) 1 metre.
(*e.*) Snow melted.
(*f.*) 7 a.m.

BADEN.—(*a.*) Tin, with a funnel shaped receiver.
(*b.*) Circular area $\frac{1}{10}$ square metre.
(*c.*) 1½ m. At three stations on a roof.
(*d.*) Price for rain, snow receiver, and measurer, 18*s.* 3*d.*
(*e.*) A cylinder ½ m. high, with a bottom to it, is put on the rain-gauge and the contents melted.
(*f.*) 7 a.m.

RUSSIA.—(*a.*) Cylindrical receivers, ½m. in height. Inside them there is a 2nd smaller apparatus, divided off by a conical perforated diaphragm, and with a cock by which the water is let off into the measuring glass. The edge of the upper vessel is bent in and out, and ends in a strong turned brass ring. The rest of the rain-gauge is made of zinc, and painted white.
(*b.*) 500 square cm. and circular.
(*c.*) 1 – 5 m., but 1 m. is the commonest height.
(*d.*) Price of the two cylinders and measuring glass, verified and packed by the mechanician of the Observatory, 34 rubles. Rain-gauges of a much cheaper form for rain stations, of the same area, cost only 5 rubles each.
(*e.*) Snow is melted.
(*f.*) 7 a.m., according to the regulations of the Congress.

DENMARK.—(*a.*) Rain-gauges are described in the Annuaire for 1874. Made of zinc.
(*b.*) Circular area $\frac{1}{10}$ square m.
(*c.*) 1·9 m. above ground.

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(*d.*) The gauge costs 12 francs, the wooden stand 9 francs.
(*e.*) The snow is measured in cylindrical vessels.
(*f.*) 8 a.m.

HOLLAND.—(*a.*) Rain-gauge of zinc of 4 square decimètres area.
(*b.*) Circular.
(*c.*) 1 metre.
(*d.*) 8*s.* 4*d.*
(*e.*) If it is continually snowing, the gauge is taken in, and another put in its place.
Snow is measured either by its weight or by the volume of water.
(*f.*) At 8 a.m. At some stations in the evening also. I should like to see the reading taken at night.

ITALY.—The gauges are of copper, and have a circular aperture of ½ m. in diameter.

10. *Do the stations possess a special wind vane for recording the direction of wind, or are the observations made by the vanes on steeples, or from the direction of smoke, &c.?*

METEOROLOGICAL SOCIETY, LONDON.—Some observers have vanes, others look to smoke.

METEOROLOGICAL OFFICE, LONDON.—There are no vanes belonging to the stations, the observers look to church vanes or to the smoke.

NORWAY.—30 stations have Wild's wind gauges. The others have no apparatus.

SAXONY.—Almost all stations have wind vanes for Direction. The central station has an anemometer. Two stations have Wild's wind vanes.

WÜRTEMBERG.—At the central station the wind vane on Wild's pattern. The other stations have employed smoke, but vanes will be erected.

BADEN.—Most stations have wind vanes.

RUSSIA.—With a few temporary exceptions all stations have wind vanes.

DENMARK.—The stations have usually special wind vanes.

HOLLAND.—Special wind vanes.

ITALY.—There is at least a special anemoscope for each station.

11. *Is the wind force estimated, and by what scale? or, do you make use of simple dial instruments (Robinson's anemometers) or vanes with pendulum-like wind gauges (Wild's or Prestel's anemometers).*

METEOROLOGICAL SOCIETY, LONDON.—Force given by Beaufort's scale. Some stations have anemometers.

METEOROLOGICAL OFFICE, LONDON.—Ditto ditto.

NORWAY.—Estimated according to half the Beaufort scale; also the measured velocity is noted.

SAXONY.—Estimated according to Beaufort and measured also at three stations.

WÜRTEMBERG.—Scale 0–4 hitherto.

BADEN.—Anemometers of Wild's or Prestel's pattern.

RUSSIA.—In a short time all stations which have not got Robinson's anemometers will be provided with Wild's wind gauges, and so will be able to give the velocity in metres per second according to the Congress resolutions.

DENMARK.—Force is measured by special instruments, and reduced to half the Beaufort scale.

HOLLAND.—At Helder, Flushing, Groningen, and Utrecht the number of kilos. on the square m. is noted, at other stations it is estimated. There are five Robinson's anemometers to check the indications of pressure.

ITALY.—At a limited number of stations there are Robinson's anemometers giving direction and velocity.

12. *Is the amount of evaporation measured at any of your stations, and by means of what apparatus? What is the extent of evaporating surface? Is the atmometer protected from sun and rain; or is the evaporation measured on an open surface of water?*

METEOROLOGICAL SOCIETY and METEOROLOGICAL OFFICE, LONDON, NORWAY, SAXONY, BADEN, DENMARK.—No.

WÜRTEMBERG.—Evaporation is measured by cylinders, the inner diameter 0·5 height 0·4 metres. Evaporation is measured by weighing the water, but this has been done very imperfectly, and most stations have given up the observation.

RUSSIA.—From the middle of the year 1876, evaporation will be measured at 30 stations by means of a balance atmometer. The area is 250 square cm., and is protected from sun and rain by being placed in a thermometer screen.

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HOLLAND.—At Helder, Leeuwarden, Utrecht, Haarlem, Oudorf, and Oude-water evaporation is measured; the area is from ¼ to 1 square mètre.

At Leeuwarden, Prestel's apparatus is used.

At the Haarlem Lake the atmometer is floating in the lake, in order to keep the temperature quite uniform with that of the water.

ITALY.—Almost all stations of the second order have atmometers, of cylindrical aperture, of 0·2m. diameter exposed to full sunshine, but protected from rain.

REPLIES.

METEOROLOGICAL SOCIETY, LONDON.

A 1. The details of the organization of the stations belonging to this society are published in the Report of the Council read at the Annual General Meeting, January 19th, 1876.

7. The tables used for reducing the barometer observations to sea-level are those given in the Instructions in the use of Meteorological Instruments, by R. H. Scott, F.R.S. Separate tables are prepared for each station and in some cases the tables combine the corrections for index error, temperature, and altitude. The mode of preparation is explained in the accompanying paper "Some remarks on the reduction of barometric readings, &c." by W. Marriott.

B 1. Pressure, temperature, and humidity of the air, wind, cloud, rain, and hydrometeors.

2*a*. Yes, stations of the second and third order.

b. No.

3. The number at the present time is:—

Second class 18.
Third „ 15.

4. The second class stations are inspected before being accepted by the society, and will be re-inspected at irregular intervals.

5. Yes; in most of the English scientific instrument makers' catalogues.

6. *a*. Standard on Fortin's principle and Kew pattern barometers.

c. Various makers.

7*a*. Mostly spherical.

b. Graduated on stem.

c. The thermometers are exposed in a screen over an open grass plot.

d. Stevenson's screen, made of wood firmly fixed and protected from terrestrial radiation.

e. 4 feet.

f. The screen has a chimney at the top for ventilation, the rotatory thermometer is not used.

g. Various makers.

8. Yes. Maximum on Negretti's and Phillips' principle, and minimum on Rutherford's construction; various makers. Read at 9 p.m.

9. *a*. Chiefly Glaisher's and Symons's; copper.

b. 8 inches and 5 inches. Circular.

c. 1 foot above the ground.

e. Melting the snow and measuring the water as rain.

f. 9 a.m.

10. Some observations are made by vanes; others by the direction of smoke, &c.

11. Wind force estimated by Beaufort's scale; Robinson's anemometer is used at several stations.

12. No.

R. H. SCOTT, Meteorological Office, London.

A 1. The details of the system of the Meteorological Office are published in its Annual Report, and also in the annexed memorandum on the organization of the Office.

2. The Meteorological Department was organized in 1854 for Marine Meteorology, and extended to Land Meteorology of the United Kingdom, in 1867.

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3. It comprises three branches—

I. Ocean Meteorology.
II. Weather Telegraphy.
III. Land Meteorology of the United Kingdom.

4. Yes, in the Annual Report, and in the annexed memorandum. (Not reprinted.)

5. Yes, from 29 home and 22 foreign stations; the statistics as to the method of dealing with and publishing them in the Daily Weather Charts and newspapers will be found in the memorandum.

6. The number of stations which take part in the U. S. Signal Office synchronous system, is given in the Annual Reports, with the names of the observers.

7. By the tables given in the "Instructions in the use of Meteorological Instruments," 1875.

8. The subject of the future organization of this Office being now under the consideration of H.M.'s Government, I cannot easily give an answer to this question.

B 1. Pressure; temperature; humidity; wind, both direction and force; rain; clouds; weather.

2. Yes.

There are a few rainfall stations, but the general question of the rainfall of the British Isles is dealt with by a private organization under Mr. George James Symons. There are no special thunderstorm stations, the climate of England is not such as to render hail observations of importance. Damage by hail is very rare.

3. In connexion with the Office there are seven observatories, stations of the first order, 17 stations of the second order, besides telegraphic stations. This, however, gives a very imperfect idea of the number of stations in the United Kingdom, in connexion with the General Register Offices in London and Edinburgh, the Meteorological Society, the Scottish Meteorological Society, and the isolated observatories of the first order, such as Greenwich, Oxford, Bidston, &c., &c.

The British rainfall organization alone embraces upwards of 1,600 stations.

4. Annually.

5. The self-recording instruments are described in the Annual Reports for 1867 and 1869.

The instruments in use at sea and elsewhere are described in the Instructions above mentioned.

6. (*a.*) For the stations of the first order, Fortin's barometers; for other stations, Kew barometers.

Aneroid barometers are not used for observations.

(*b.*) The limits of error in Kew barometers are—all rejected for which the index error, at the ordinary pressure, is greater than 0·015 in. =0·4 mm., or capacity error greater than 0·004 in. =0·1 mm., and in which the mercury does not fall from 1·5 to ·5 inch above the present pressure in a time between three and six minutes.

For barometers professing to be standards reject all with index error greater than 0·010 inch = 0·25 mm.

(*c.*) For the most part from Adie, Pall Mall, London.

	£	s.	d.	
Price of Kew barometers - -	3	10	0	if ordered singly.
Verification fee - - -	0	10	0	
	4	0	0	

If barometers are ordered in larger numbers, say 12 at once, the price is 3*l.* 5*s.* 0*d.*

7. The thermometers known in the trade as K. O. (Kew Observatory) thermometers.

a. Spherical bulbs.

b. Graduated on the stem.

(*c.* and *d.*) Whenever possible exposed in Stevenson's screen, in the open air, over grass; where this is not possible, in a small wooden louvred wall screen.

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The thermographs are in large louvred wall screens.
The screens are figured in the "Instructions" already quoted.
Moveable screens are not used.
The Stevenson's screens are not completely protected from terrestrial radiation.
e. At the height of four feet, at stations of the second order.
f. No arrangement for ventilation is employed. The rotatory thermometer is not used.
g. The price of the thermometers is 5*s.*, the verification fee is 1*s.*
The makers are various, the best in London, as far as this Office knows, are,—

L. P. Casella & Co., Holborn Bars.
J. J. Hicks & Co., 8, Hatton Garden.
Negretti and Zambra, Holborn Viaduct.
Pastorelli & Co., 208, Piccadilly.

8. The minimum thermometers are of Rutherford's construction, in some cases with forked bulbs.
The maximum thermometers are on either Negretti's or Phillips' principle, but the former are more usual.
The makers are the same as for the ordinary thermometers.
The cost is 18*s.* 6*d.* in each case, the verification fee is 1*s.*
The maximum and minimum instruments are read at 9 p.m.
9. *a.* Glaisher's pattern, with cylinder at top to catch snow. Material, copper.
b. Circular, 8 ins. diameter.
c. 1 ft. 9 ins.
d. 2*l.* 2*s.* 0*d.*
e. The snow in the gauge is melted.
f. At 9 a.m., and entered to preceding day.
10. A wind vane is not supplied, but the observers consult such on steeples, first satisfying themselves that it is correctly set. Smoke is sometimes employed to show direction of wind.
11. Estimated by Beaufort's scale. At the observatories and some other stations Robinson's anemographs, full size, are employed.
12. Evaporation is not measured at any of our stations.
It should be remarked that the prices quoted are the *contract prices* for the respective instruments to this Office.

H. Mohn, Meteorological Institute, Christiania.

A.

1. Yes. In the "Norsk Meteorologisk Aarbog." See also "Ocean Highways: The Geographical Review," edited by Clements R. Markham, C.B., F.R.S., new series, vol. I. pp. 12 and 157.
2. In December, 1866.
3. Only one department. Sea observations are collected, but little discussed, for the want of working power. The Magnetic Observatory at Christiania belongs to the Observatory.
4. The financial estimate has been continually increasing, for the time being it will be found in "Ocean Highways," *loc. cit.*
5. Telegraphic reports are received from seven stations in Norway, four in Sweden, two in Denmark, and four in Great Britain and Ireland. A daily synoptic chart is constructed from these, a bulletin is drawn up with probabilities for the weather of the next day and is posted up. A condensed bulletin is published in "Morgenbladet" and "Aftenbladet," but not quite continuously, as Sunday is often missing. If appearances are threatening storm warnings are dispatched to the coast, with an indication of the direction of the impending wind. The most accurate publication of our Weather Telegrams is in the "Bulletin du Nord."
6. Yes. The stations are Christiania, Bergen, and Tromsö. From the 1st January 1876 Bodö will be added.
7. Most stations lie so little above the sea that constant values for reductions can be applied with an accuracy of ± 0·1mm. For the higher stations, in

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the interior, the reduction is made by means of calculated and graphical tables drawn up specially for the station, the arguments being air temperature and height of the barometer. The temperature used in the reduction is the mean of that of the higher station and of one or more at the level of the sea.

8. A special house or fixed *locale* for the Institute in the town. A meteorological observatory some distance from the town of Christiania. Several of the latter on the West Coast and in Arctic Norway. A department of the Institute for Maritime Meteorology. Extension of the Storm Warning system by several reporting stations in Northern Norway and abroad (Germany, Russia, and if possible in the Faroes and Iceland). Several assistants in the Office.

B.

1. 32 stations have mercurial barometers; 44 aneroid barometers; 50 dry-bulb thermometers: 44 minimum thermometers; 36 dry and wet bulb thermometers; 8 hair hygrometers; 38 rain-gauges; 30 wind-vanes with velocity-plate (Wild's); 10 sea-thermometers, (for the surface); besides wind-force, cloud, and kind and time of precipitation are observed at all stations. This organisation was completed in 1875. Before that time minimum thermometers, wind-gauges, and aneroids were not observed.

2–3. We have no station of the 1st order. The 32 stations with mercurial barometers are completely of the second order, the rest with aneroids only somewhat less completely so. We have no special rain stations in action. Observations of thunderstorms are made by about 150 volunteer observers yearly.

4. In southern Norway, on the coast, yearly or every second year; in the interior at least every third year. In the north and in Finmark, at least every fourth year.

5. See A. 1. The new arrangements, which were introduced in 1875, are not yet described.

6 (*a.*) 16 stations have Fortin's barometers, 16 have Kew barometers. All 32 have aneroid barometers as reserves. 10 lighthouse stations and two others have aneroid barometers. The older syphon barometers with two scales, on a mahogany slab, and partially with verniers, are no longer in use. In Bergen there is a syphon barometer with microscopes (by Deleuil).

(*b.*) The average error of a comparison with the normal barometer is, for Fortin's barometers $\pm$ 0·045 mm. and for Kew barometers $\pm$ 0·044. The constant difference for Fortin's is on an average — 0·65 mm., for Kew barometers — 0·21mm.

(*c.*) Fortin's, partly from Secretan of Paris, but mostly from Olsen of Christiania. The Kew barometers from Adie. The price of both kinds is about 120 francs.

7. (*a.*) Spherical.

(*b.*) The scale is of paper, in centigrade degrees, graduated to $\frac{1}{5}$° and hermetically closed in the glass. The outer glass tube is sealed at the top. No brass plate with cement.

(*c.* Outside a window, or against a wall.

(*d.*) Formerly screens of various sizes, with louvres of wood fitted to the outer sides. Now (since the summer 1875) everywhere sheet-iron screens with roof, painted yellow, for dry and wet bulb thermometers, with louvres outside, open if against a window, with louvred door if against a wall. By screening boards, or by putting up two screens, shade may be always obtained several hours before an observation. It is only in Christiania that there is a screen with double louvres and double roof, closely adjoining the window. The screens at the stations are 0·6m. high, 0·25m. wide and 0·2m. deep. They are supported by iron holdfasts. The air passes freely between the window or wall, and the screen. The screens have space for dry and wet thermometers, minimum thermometer and hair hygrometer. At the stations which observe air temperature, but not the dry and wet thermometers, we have cylindrical screens, having plain sides with a slit for observing the thermometer scale, and with simple conical roofs. The minimum thermometers at these stations are in special screens with double sides and placed outside a window. The whole screen is supported by a holdfast, just like an ordinary thermograph. All the recent screens are open below. But the

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sides project so low that the thermometer bulbs are but little affected by terrestrial radiation.

(*e.*) At very different heights, from the first to the third storeys. The average height is 2·8 metres. The mean deviation from this is ± 1·3m. Greatest height 13·1m., least 0·9m.

(*f.*) No. No.

(*g.*) Of Ådermann in Stockholm (also of Grave of the same place). The wet and dry bulb thermometers ($\frac{1}{5}$°) cost 2 sp. = 8 Kroner = 3 Thalers each. The minimum thermometers (whole degrees) cost 5 Kroner each.

8. (*a.*) Maximum (Negretti and Zambra's) in Christiania only. Minimum (Grave, at 5 Kroner) at all stations, since the summer of 1875.

Maximum, at Christiania, in the evening.

Minimum at the morning observation; if the temperature is not falling at the time, so that the index shows the air-temperature, in which case the instrument would be read later.

9. (*a.*) The older ones of zinc, with a strong brass rim, the latter ones of sheet iron, we use circular ones of one Norwegian square foot and of 0·1 square mètre. The recent ones are square. The side = 0·15m. Height = 0·5m.

(*c.*) Various; from 0·4m. to 4m. (and 15m. on a roof). Average height 1·4m., the mean deviation from which is ± 0·62m.

(*d.*) The rain-gauge, with side of 0·15m. and two measuring tubes is 2½ sp. (about 15 francs). The measuring tubes are graduated at the Institute

(*e.*) The snow is melted in the rain-gauge in a room and the melted water measured in the glass.

(*f.*) At the hour of the morning observations, or in winter as soon as it is light.

10. 30 stations have Wild's wind gauges, since the summer of 1875. At the Fiord stations and in the narrow valleys, we have no instrument for measuring the wind, as there the wind is of an extremely local character. Formerly only a few stations had wind vanes.

11. The estimated force, as well as the measured velocity, is now always noted at the stations which have wind gauges. At the other stations the direction and force are estimated. The scale is 0—6.

12. Evaporation is not measured at any station. The temperature of the sea-surface and the sea-disturbance (scale 0—9) and direction are observed daily at nine lighthouse stations.

Dr. C. Bruhns, Observatory, Leipzig.

A.

1. Yes, in the 1st Annals of the Results of Meteorological Observations, Leipzig, 1865.
2. December 1863.
3. A department for Land Meteorology.
4. No. (About 12,000 marks.)
5. No. The Central Institute for Weather Observations for Germany is the Deutsche Seewarte at Hamburg.
6. Yes. See "Bulletin of War Department."
7. According to the strict formula, with regard to pressure and temperature.
8. Union of the German systems under one management and the issue of *one* German publication.

B.

1. The usual elements.

2 and 3. 1. Stations of the 1st order.
19. „ 2nd „
5. „ 3rd „ and also some stations for rainfall.
None for hail or thunderstorms.

4. Yearly; some half-yearly.
5. Published in the 1st Annals of Results.
6. (*a.*) 1 Fortin's barometer; 1 Adie's, all the rest syphon barometers

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fitted with microscopes. As reserves we use syphon barometers with scales on the tubes without microscopic fittings, and aneroid barometers.

(*b.*) Error of comparison with normal ± 0·05mm. A constant difference between normal and station barometers does not exist.

(*c.*) The first 20 station barometers are by J. G. Greiner of Berlin, the latter ones by Schadewell of Dresden, price 180 marks and 120 marks.

7. Mercurial thermometers are used at all stations.

(*a.*) Spherical bulbs.

(*b.* Porcelain scales and firmly cemented.

(*c.*) Erected outside windows.

(*d.*) Screen, moveable zinc boxes, partly with double louvres. No protection at bottom.

(*e.*) On an average four metres. Varies from 2—9 metres.

(*f.*) Neither arrangement for ventilation, nor rotary thermometers.

(*g.*) The first thermometers by J. G. Greiner of Berlin; later ones by Leyser of Leipzig. Price 24 marks and 18 marks.

8. Spirit minimum thermometers at all stations. Maximum thermometers with steel wire at some stations. All metal maximum thermometers, &c. have got out of order. Greiner's minimum thermometers cost 24 marks. Leyser's 15 marks.

9. (*a.–c.*) Zinc rain-gauges of the prescribed form, with strong brass rim. Circular, 1,000 square cm. in area. 1½ metre above the ground.

(*d.*) Rain-gauge has two receivers. Stand of iron. Price with measuring glass about 60 marks.

(*e.*) Snow thawed and measured.

(*f.*) Read early in the day.

10. Almost all stations have wind vanes for direction. The Central Station has an anemometer; two stations Wild's wind vanes.

11. Estimated according to Beaufort's scale; at three stations measured also.

12. No.

Dr. SOHNCKE, Meteorological Central Station, Carlsruhe.

A.

1. Yes, in the First Annual Report of the Central Station, Carlsruhe, 1869.
2. In the autumn of 1868.
3. A department for Land Meteorology.
4. No.
5. No. The "Deutsche Seewarte" at Hamburg is the Central Institute.
6. Yes, See "Bulletin of War Department."
7. According to the strict formula, the constants according to Jordan's "Notizkalender."
8. Observations on Evaporation and Earth temperature. Self-registering Observations.

B.

1. The usual elements.

2 and 3, 12 stations of the 2nd order.
4 „ 3rd „
1 station for rainfall.

4. Yearly.

5. In the Swiss Instructions and in the First Annual Report of the Baden Observations.

6. (*a.*) Cistern barometers with vernier, without microscope. No aneroids.

(*b.*) Difference of the station barometers from the normal barometer is — 0·39mm. (The correction for capillarity corresponding thereto = + 0·4mm.)

(*c.*) Hermann and Pfister of Berne. Price 68 marks.

7. Centigrade thermometers, graduated to ½°.

(*a.*) Spherical.

(*b.*) Graduation on a special scale.

(*c.*) Outside the window.

(*d.*) In metal screens with perforated sides and roof. When necessary a protecting board is added. There is no protection against terrestrial radiation.

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(*e.*) Between two and 12 metres.
(*f.*) No arrangement for ventilation, no rotary thermometers.
(*g.*) Hermann and Pfister at Berne, price 13·6 marks.
8. Mercurial maximum thermometers. Spirit minimum. Maker J. Greiner of Munich.
Price of maximum thermometers 10·3 marks.
„ Minimum „ 9 „
Read at 9h. p.m.
9. (*a.*) Tin receiver, with funnel-shaped top.
(*b.* Circular. Receiving surface $\frac{1}{20}$ square metre.
(*c.*) 1·5 metre. At three stations on the roof.
(*d.*) Price of rain and snow-gauge with measuring glass 18·3 marks.
(*e.*) A cylinder 0·5 metre high, with fixed bottom is fitted to the rain-gauge and the snow melted.
(*f.*) 7h. a.m.
10. Most stations have wind vanes.
11. Wild's and Prestel's anemometers.
12. No.

Dr. SCHODER, Central Meteorological Station, Stuttgart.

A.

2. 1874.
3. A department for Land Meteorology.
4. No. (4,500 marks, without publication.)
5. No. The Central Institute for Weather Telegraphy is Hamburg.
6. Yes. See "Bulletin of War Department."
7. According to the strict formula.

B.

1. The usual elements.
2 and 3. 14 stations of the 2nd order.
7 „ 3rd „
4. Partly yearly, partly biennially. The stations of the third order occasionally.
5. (*a.*) 7 cistern barometers by Hermann and Pfister of Berne, without microscope with vernier. 1 syphon barometer by Kappeller of Vienna. The rest syphon barometers which will be replaced by cistern barometers. No aneroids.
6. (*c.*) Price of the cistern barometers 140 marks.
„ syphon „ 68 „
7. (*a.*) Spherical.
(*b.*) Glass and porcelain scales, the first giving $\frac{1}{2}$°, the latter 0°·2.
(*c.*) Erected mostly outside windows.
(*d.*) Wooden louvre screens. Comparisons of temperature with wooden louvred and metal screens result in favour of the wooden screens.
(*e.*) Height between three and 10 metres.
(*g.*) A thermometer graduated to 0°·5 costs 8·5 marks.
„ „ 0·2 „ 12 „
8. Everywhere maximum and minimum thermometers: the former do not always act well.
1 maximum thermometer costs 9 marks.
1 minimum „ 7 „
9 (*a.*) Tin.
(*b.*) Square, 1 Paris square foot.
(*c.*) 1 metre above the ground.
(*e.*) Snow melted and water measured.
(*f.*) At 7 a.m.
10. At the central station, there are wind vanes of Wild's construction, the other stations observe hitherto according to smoke, &c., but vanes will be erected.
11. Scale hitherto 0–4.
12. Evaporation is measured in two cylinders. Interior diameter 0·05 and 0·04 metre. The evaporation is determined by weighing the water, but it has been very unsatisfactory.

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Professor H. WILD, Central Physical Observatory, St. Petersburg.

The questions contained in Circular E. are almost, without exception, answered by the Annual Reports and the introductions to the Annals of the Central Physical Observatory, and lastly in the Instructions for Russian stations contained in the "Repertorium für Meteorologie." I may add that very recently we have introduced the Code for Weather Telegraphy, and that we are actually engaged in providing all stations with the wind-vanes with pressure plates, and in supplying my balance atmometer to about 30 stations. Sixteen new stations were organised in the year 1875, and five more this year already.

Dr. H. WILD, Central Physical Observatory, St. Petersburg.

A.

1. Yes, in the Annual Reports of the Central Observatory.
2. 1849. Reorganized 1872.
3. Four departments. (*a.*) Land Meteorology. (*b.*) Maritime Meteorology. (*c.*) Weather Telegraphy. (*d.*) Terrestrial Physics. A magnetic observatory belongs to the 4th Department.
4. No. It amounts at present to about 59,000 roubles.
5. Yes, 45 stations in the interior, 24 abroad. A bulletin, without chart, is published daily which also appears in several newspapers. Storm-warnings are issued.
6. Yes, See "Bulletin of War Department."
7. According to the strict formula, with regard to pressure and temperature.
8. A department for Agriculture, and Forest Meteorology.

B.

1. The usual elements and evaporation.
2 and 3. 1. Central Observatory.
6 stations of the 1st order.
118 „ 2nd „
About 220 „ for rain.
„ 350 „ for thunderstorms.
4. Inspection at irregular intervals.
5. Partly in the First Instructions, Repertorium, Vol I.

The atmometer, cistern barometer and wind vane are described in the Bulletins of St. Petersburg Academy.

The new thermometer screens are not yet described.

6. (*a.*) Syphon barometers, by preference, the mercury being raised in both legs before the observation, without microscope.

Some cistern barometers with wide cistern.
„ „ on Fortin's principle.
A number „ on Parrot's „
(float on the outside level of the mercury) especially in the Caucasus.

At all new stations aneroids are kept as reserves.

At stations of the 1st order, and at the mining establishments each 2 or 3 mercurial barometers.

Some distant stations, which are difficult of access, have only aneroids, thermo-barometers being kept as checks.

(*b* and *c.*) Average error of a comparison ± 0·09 mm.

Difference from the normal barometer ± 0·04 mm.

Constant correction from 0 to ± 1 mm.

The new cistern barometers are made by Turrettini of Geneva, filled by the optician of the St. Petersburg Observatory, and there verified and packed. Price 80 roubles = 256 francs.

7. (*a.*) Spherical.

(*b.*) Porcelain scale, graduated to $\frac{1}{5}$°. Outer tube with brass fitting hermetically sealed.

(*c* and *d.*) Iron screens with louvres, erected in two cylindrical cases, partly 0·3 metre from the window on the north side and protected from the sun by a wooden board, mostly, however, in wooden screens of 2 cb. m. and open towards the north, massive double roof and side to the south. Louvres to east and west. In the new screens radiation from below is also prevented.

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(*e.*) 2·5—3 metres, higher at some stations.

(*f.*) No.

(*g.*) From Geissler of Bonn and verified by the optician of the Observatory at St. Petersburg, Price 8 roubles = 26 francs.

8. Only spirit-thermometers at all stations, graduated to $\frac{1}{5}$°, with forked bulb, by Geissler of Bonn.

Price 8 roubles = 26 francs.

Read at 9h. p.m.

9. (*a.*) A cylindrical collector 0·5m. high, and below, separated by a conical sieve bottom, a second smaller receiver with cock by which the water caught is read off in the graduated glass cylinder. The rim of the upper vessel is bent outwards and inwards and terminates in a strongly turned brass ring. The rest of the rain-gauge is of zinc, painted white outside.

(*b.*) 500 square cm. and circular.

(*c.*) 1–5 metres, but the most usual height is 1 metre.

(*d.*) Two receivers with measuring glass verified and packed by the optician of the Central Observatory, 34 roubles. Much simpler rain-gauges for rain stations, but of the same area, cost only five roubles each.

(*e.*) The snow in the funnel is taken into a warmed room and melted.

(*f.*) According to the regulation of the Congress, at the first observation of the day (7h.)

10. All stations, with few temporary exceptions, possess special wind vanes.

11. In a short time all stations which do not possess Robinson's anemometers will be supplied with my wind pressure plate and so can give the wind velocity directly, in metres per second, according to the decisions of the Congress.

12. The evaporation has been measured from the middle of the year 1876, at 30 selected stations, by means of my balance atmometer. The evaporating surface of the same is 250 square cm., protected from sun and rain by being fitted up in the thermometer screen.

Captain Hoffmeyer, Meteorological Institute, Copenhagen.

A.

1. The details of the organization of the Danish Meteorological system have been published in the Annals of the Institute for the year 1874.

2. The Danish Meteorological Institute was founded in 1872.

3. The Institute undertakes researches in climatology, the telegraphic service, and hydrography.* A magnetic observatory is not annexed to the Institute.

4. The financial estimate is not published. That for the year 1875–6 is as follows :—

	Francs.
Salaries of a director, and two assistants - -	7,400
Calculators, draughtsmen, and porter - - -	3,600
Observers at stations of the 2nd order - - -	2,540
Sundry expenses (maintenance of instruments, publications, inspections, office expenses, &c. - -	7,860
	21,400

5. The Central Institute receives every day Meteorological Reports from 8 Danish and 19 foreign stations.

6. Vestervig, Fanö, and Copenhagen in Denmark; Thorshaven in the Faroes; Stykkisholm in Iceland; Godthaab in Greenland;—altogether 6 stations take part in the synchronous observations proposed by General Myer.

7. As the height of the Danish stations does not exceed 50 metres, constant corrections are employed for reducing the barometer observations to the sea level.

B.

1. The stations observe the atmospheric pressure, temperature and its extremes, the humidity of the air, the wind, sky, weather, and rainfall.

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* *i.e.* Sea Temperature, &c.

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2 and 3. At the beginning of the year 1876 we have—

A Central Institute.

1 station of the 1st order (two hourly readings of the barometer, and wet and dry bulb thermometer).

15 stations of the 2nd order.

160 stations of the 3rd order (60 stations for climatological elements, 71 stations for rain only, 25 stations for wind, and 4 hydrographical stations).

4. The stations of the 1st and 2nd order are inspected yearly in Denmark, the Faroes, and Iceland, but not in Greenland.

Of the other stations a certain number are inspected each year.

Reports of these inspections are drawn up, accompanied by detailed descriptions and by sketches.

5. A general description of the instruments will be found in the Annals for 1874.

6. *a*. The barometers in Denmark are of Kappeller's pattern, in the Colonies of Fortin's or Kew (Marine) pattern. Aneroids are not used.

b. The barometers at the stations now differ from 0·1 to 0·2 mm. from the standard barometer.

c. The standard barometer and the barometers of Kappeller and Fortin's pattern are made at Copenhagen (160 francs), the Kew pattern barometers are got from Adie of London (130 francs).

7. (*a*.) The thermometers have spherical bulbs.

(*b*.) They are provided with a separate scale.

(*c* and *d*.) They are placed in spacious wooden screens fitted with double louvres, facing the north, and hung in the shade of a house, or with a special contrivance against the wind. At the stations of the 1st and 2nd order the thermometers are protected from terrestrial radiation.

(*e*.) The height of the thermometers above the ground is 1½ metre.

(*f*.) There is no ventilation, and no rotary thermometer.

(*g*.) The thermometers are made at Copenhagen, graduated to 1/5°; they cost 30 francs; and if divided to ⅛°, 7 francs.

8. A great number of stations are provided with maximum and minimum thermometers; the former are of Phillips' pattern (but hung vertically); the latter are of Rutherford's pattern.

9. (*a*.) The construction of the rain-gauges is shown in the Annals for 1874. They are made of zinc.

(*b*.) The size of the circular funnel is 0·1 square metre.

(*c*.) The funnel is raised 1·9 metre above the ground.

(*d*.) The rain-gauge with a measuring tube costs 12 francs, the wooden stand costs 9 francs.

(*e*.) Snow is measured in cylindrical vessels (*See* the Annals for 1874.)

(*f*.) The rainfall is measured at 8h. a.m.

10. The stations are usually provided with conical streamers serving as wind vanes.

11. The wind-force is not measured by instruments, but estimated according to the scale 0—6.

12. We take no account of evaporation.

Professor Buys Ballot, Royal Meteorological Institute, Utrecht.

A.

1. No.

2. Privately in 1849. Officially in 1854.

3. Two departments, one for Land Meteorology, one for Maritime Meteorology.

There is a magnetic observatory. The constants are determined absolutely twice monthly.

Only the declination is registered photographically.

4. Not published, it amounts to 14,500 guilders.

5. Yes; from four stations in the interior, 14 abroad.

The telegrams when reduced are posted up in the ports and published in the newspapers.

The Aeroklinoscope announces at a distance the state of the atmosphere.

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6. Yes; from four stations. See "Bulletin of War Department."
7. By a constant correction, as no height above the sea amounts to 50 metres.
8. We are striving to obtain in Utrecht self-registered barometer readings from the chief stations.

B.

1. All the usual elements, also, in Utrecht and Helder, Electricity with Peltier's apparatus.
2–3. Yes; Utrecht, Helder, Groningen can be placed in the first class. Leeuwarden, Tilburg, Hellevoetsluis, Maestricht in the second, Assen and Amsterdam in the third, and Zaandam in the fourth. Rainfall is observed at 30 other stations.
4. A general inspection is made once in three years. Sometimes one and sometimes another station is inspected at irregular intervals.
5. In a publication by Dr. Krecke.
6. (*a.*) Four syphon barometers and six cistern barometers. No aneroids. At some stations two barometers are always in use.
6. (*b.*) The error of a comparison, with proper care, does not exceed 0·05 mm.
The greatest correction is not 0·3 mm.
7. Mercurial thermometers.
(*a.*) Spherical.
(*b.*) Graduated on the tube.
(*c.*) Outside the window, protected by glass louvres.
(*e.*) The height is variable, 1 – 3 metres.
(*f.* and *g.*) From various sources and at various prices.
8. By Greiner; from Utrecht and also from Negretti and Zambra.
The maximum and minimum thermometers are read in the afternoon, and at Utrecht in the morning also.
9. The area of the rain-gauges is 4 square decimetres. Circular, made of zinc.
(*e.*) One metre.
(*d.*) 5 guilders.
(*e.*) If it is snowing continually, the rain-gauge is brought in and another is put in its place. The snow is determined by weight or by the volume of water.
(*f.*) At 8 a.m. At some stations in the evening also. I should like to see the evening reading generally introduced.
10. Special wind vanes.
11. At Helder, Flushing, Groningen, and Utrecht the number of kilograms on the square metre is noted. At other stations it is estimated; besides there are five Robinson's anemometers for checking the indications by pressure.
12. At Helder, Leeuwarden, Utrecht, Haarlem, Oudorp, and Oudewater, evaporation is measured. The surface from ¼ to 1 square metre. At Leeuwarden, Prestel's apparatus is used. At the Haarlem Lake the atmometer floats in the lake, in order to get the temperature quite uniform.

Professor J. CANTONI, University, Pavia.

A.

1. Not yet completely. Some account is given of them in the Supplement to the "Meteorologia Italiana" for 1873, presented to the Vienna Congress.
2. The bulletin of the "Meteorologia Italiana" published by the Ministry of Agriculture and Commerce, was established in 1864.
3. The Office charged with the publication of the above-mentioned bulletin, is quite distinct from that which issues the forecasts and notices of the weather for the use of seamen, receiving telegraphic reports from a certain number of stations. This latter Office is placed under the Ministry of Marine.
4. The financial estimates of these offices are not published.
5. The Ministry of Agriculture, of which alone I shall speak in future, receives every decade the observations from more than 80 meteorological stations.
6. More than 30 stations also send synchronous observations, of which above 20 are sent each decade to General Myer.

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7. The reduction of barometer observations to sea level is effected by corrections varying with temperature and pressure, according to the tables published by the Ministry of Agriculture.

8. They have been explained in the Report of the Meteorological Commission, at its meeting at Palermo, September 1875.

B.

1. The majority of our stations are provided with barometer, maximum and minimum thermometers, dry and wet bulb thermometers with ventilation, which also give the temperature of the air, rain-gauge, atmometer, and wind-vane; several have also an anemograph, Palmieri's electrometer, and a small number have magnetic and seismographic instruments.

2. Yes, they are separated into three classes, according to the decisions of the Vienna Congress.

3. A Meteorological Commission is at present engaged in determining the number of stations in each class. I may say that in Italy there are at least 30 stations of the second order which are pretty good.

4. The above commission has expressed its wish that, from the present time, the inspection of stations of the second order should be made, if possible, every year, or at least every two years.

5. See "Norme per le Osservazioni Meteoriche," published in 1875.

6. See the same Instructions.

(*a.*) The majority of stations use Fortin's barometers, or a syphon of large size. Observations are never taken by aneroids.

(*b.*) A memoir by M. Denza is about to appear in the Supplement for 1875, on the comparison of a good number of our barometers.

(*c.*) Most are obtained from the physical establishment (Tecnomasio) at Milan. Fortin's barometers, with large cisterns, cost 100 francs, and the large syphon-barometers, 120 francs.

7. (*a.*) The thermometer bulbs are cylindrical and the diameter relatively to the length small.

(*b.*) They are graduated on the stem.

(*c–d.*) Placed outside a window, facing the north, and protected from radiation by louvres.

(*e.*) At different heights according to the conditions of the building.

(*f.*) The thermometers are all subjected to ventilation, produced by the wheel of the psychrometer.

8. The two maximum and minimum thermometers are separated from each other. The maximum is mercurial and the minimum amylic alcohol. The maximum is read at 9 p.m., and the minimum at 9 a.m.

9. The rain-gauges are of copper, with a circular funnel of 0·5m. diameter.

10. There is at least a special wind-vane at each station.

11. At a limited number of stations there are Robinson's anemometers, registering at the same time both direction and velocity of the wind.

12. Nearly all the stations of the second order have atmometers, with cylindrical pans of 0·2m. diameter, freely exposed to the sun, but protected from rain.

J. D. Campbell, Chinese Maritime Customs, London.

I regret that I am unable to furnish your Committee with the desired information relative to the Meteorological organization in China, which Mr. Hart proposed to establish. The necessary instruments for 20 stations have been sent out and I trust I shall soon be able to report that observations are being taken and recorded in accordance with your recommendations.

Dr. R. Wolf, Observatory, Zürich.

I think that the Swiss Commission has already accomplished what the Committee desires.

The forms adopted for the different orders of Swiss stations from last year correspond almost entirely to its proposals. The observations made at the normal stations are printed and issued monthly, the old series are either already printed or in the press.

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APPENDIX I. TO REPORT OF PERMANENT COMMITTEE, 1874.

CIRCULAR requesting INFORMATION respecting the EXISTING SERIES of METEOROLOGICAL OBSERVATIONS in various COUNTRIES.

In order to facilitate meteorological investigations it would assist materially if it were known what series of printed or unpublished observations, extending over many years, exist in the various countries.

The Congress of Vienna commissioned the Permanent Committee to collect and publish the data in question, and in the execution of this duty I venture to address the following questions to you, and in the interest of science, request the favour of a reply to the same by the end of May 1875.

1. What meteorological publications have hitherto emanated from your institution? It is desirable to give the exact titles, number of volumes, years, and also the publishers.

2. What other meteorological publications of importance, especially those referring to a series of years, exist in your country? Particulars as to the titles, publishers, date, and price are desirable.

3. Are there any series of unpublished observations in your district? Is provision made for their safe preservation? Are manuscript copies of such made and lodged in any certain place?

4. Are such series of observations which are only in MS. available for use, and in what manner? Are the originals lent out, or can they be referred to where they are kept, or are copies supplied with or without payment?

5. Do any tables of the monthly and yearly mean values of the most important elements exist, especially for Temperature, Rainfall, Pressure, and Wind; or if normal values are deduced from them, a copy of the above-mentioned mean values (for each separate year), or at least of the calculated normal means, with particulars as to the number of years from which they were deduced, would be thankfully received by the Permanent Committee.

As the Committee wishes to take up as little as possible of your time in answering the above questions, I beg to state that, in the event of their having been already answered elsewhere, a reference to the publication in which they appear would perfectly suffice.

(REPLIES to APPENDIX I.)

ALEXANDER BUCHAN, Scottish Meteorological Society.

All necessary information regarding old unpublished Meteorological Observations in this Office will be found in Report British Association for 1873. The discussion of the oldest of our registers is far advanced and the results will probably be given in our next journal. The discussion of the others will soon follow.

As regards the stations established by the Society in different countries it may be enough to refer to our Journal for information on the subject.

Dr. C. JELINEK, K.K. Central-Anstalt für Meteorologie, Vienna.

I have the honour to submit the following statement:—There are in our possession besides the records of the stations in Austria and Hungary for 1851–70 and for those in Austria for 1871 to this day—

1. Observations made at Graz in the years 1837 to 1840 and 1843 to this time.

2. Observations taken at Fünfkirchen, Hungary, 1814–1829, 1836–1843, 1852–1858, of which the results have not yet been published.

3. Observations taken at Durazzo, Turkish Albania, from October 1868 to this time.

4. Observations taken at Valona, Turkey from 1855 to 1871, with some interruptions.

5. Observations made at Corfu from 1823 to 1861 (including) a copy of the individual observations made I think by the Corps of Royal Engineers.

6. Observations made at Corfu from November 1868 till present time.

Observer a retired Captain of the mercantile marine, Antonio Dabovich.

7. Observations from Sulina.

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8. Observations made at Tebizond in the years 1858, 1859, 1860.

9. Observations made at Athens, October 1857 to June 1859.

10. Observations made at Beyrout by the director of the observatory of the Syrian Evangelical University, Professor Van Dyck, two months, January to the middle of August, 1876, and the promise to send the continuance.

11. Observations made at Alexandria, Egypt.

a. Individual observations taken in the Collegio Italiano from June 1st, 1873 to September 30th, 1874.

b. Monthly and yearly result of observations made 1870 to 1874 (inclusive) by Signor A. Perona.

c. Individual observations from January 1st, 1873, to the present time, made by the same gentleman, with monthly and yearly results.

12. Results of observations made by engineers of the Suez Canal Company at Port Said, March 1866 to October 1869.

13. Monthly results of observations made at Ismailia, April to December 1866, and January to October 1869.

Individual observations made in the year 1867.

14. Individual observations made at Cairo, in the years 1857 to 1861.

15. Monthly results of observations made at Suez from April 1866 to October 1869.

16. Meteorological observations made at Tangiers, March 1830 to November 1835.

17. *a*. Individual observations made at the National Preparatory School at Mexico, 11 months, January to November 1873.

b. Individual observations made at the National School for Agriculture and Veterinary Science, 11 months, January to November 1873.

c. Daily means of temperature for the first half of 1873. The observation made by Mr. Isidore Epstein, in Mexico; a printed sheet with diagrams.

18. Meteorological observations (individual) made at the Naval School of Dantzic from 1856 to 1875.

19. Individual observations taken at the "Paso di Suan Juan Michapan," height 260m. above the Gulf in the four months, January to April 1873, printed.

[At the same time I take the liberty to point to the Index, pages 184 and 185 of the first volume (1864) of the new series of the "Jahrbücher," of the Central-Anstalt, where are given references to long-continued series of observations and monthly and yearly results deduced from them. Among other tables of results there are to be found in the old, or first, series of the Jahrbücher (1848–1856).

1. The monthly results of meteorological observations made at Fünfkirchen (Hungary), 1819–1832.

Jahrbuch, vol. II (1st series), 1850, page 157.

2. The monthly results of meteorological observations made at Graz (Styria), 1836–1845.

Jahrbuch, vol. II. (1st series), 1850, page 169.

3. The monthly results of observations taken at Cracow, 1826–1847.

Jahrbuch, vol. II. (1st series), 1850, page 180.

4. The monthly results of observations made at Kremsmünster, 1763–1851.

Jahrbuch, vol. I. (1st series), 1848–1849, page 149.

5. The monthly results of the meteorological observations made at Prague in the years 1775 to 1851.

Jahrbuch, vol. I. (1st series), 1848–1849, page 115.

6. Monthly results of the meteorological observations made at Salzburg, 1842–1851.

Jahrbuch, vol. I. (1st series), 1848–1849, page 186.

7. The monthly results of meteorological observations made at Senftenberg, 1843–1852.

Jahrbuch, vol. II. (1st series), 1850, page 200.

8. The monthly results of meteorological observations made at Stanislau (Galicia), 1839–1850.

Jahrbuch, vol. II. (1st series), 1850, page 164.

9. The monthly results of meteorological observations made at Trient (South-Tyrol), 1816–1832.

Jahrbuch, vol. I. (1st series), 1848–1849, page 208.

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10. The monthly results of meteorological observations made at Trieste, 1841–1850.

Jahrbuch, vol. I. (1st series), 1848–1849, page 196.

The monthly and yearly results of the meteorological observations made at Trieste, 1841–1873.

Jahrbuch, vol. IX. (2nd series), 1872, p. 173.

11. *a*. The monthly results of meteorological observations made at Udine, 1803–1842.

Jahrbuch, vol. IV. (1st series), 1852, page 139.

b. Means for the single hours of observation at Udine, 1803–1842.

Jahrbuch, vol. IV. (1st series), 1852, page 310.

12. The results of meteorological observations made at the Astronomical Observatory of Vienna, 1775–1850.

Jahrbuch, vol. I. (1st series), 1848–1849, page 35.

13. The monthly results of meteorological observations made at Wilten (a suburb of Innsbrück), 1830–1854,

Jahrbuch, vol. IV. (1st series), page 277.

14. Investigations into the climatographical conditions of Cracow, based on 45 years' observations, 1826–1871.

Jahrbuch, vol. VII. (2nd series), 1870, p. 209.

15. The monthly and yearly results of the observations at the K.K. Central Anstalt, Vienna, 1852–1872.

Jahrbuch, vol. VIII. (2nd series), 1871, p. 187.

16. The monthly and yearly results of the observations at Bodenbach, 1828–1873.

Jahrbuch, vol. IX. (2nd series), 1872, p. 196.

17. The monthly and yearly results of the observations at Pola, 1864–1873.

Jahrbuch, vol. X. (2nd series), 1873, p. 183.]

In the enumeration of the individual observations I have omitted those taken at some stations in England and Scotland, as

Edinburgh (Royal Engineers), 1856–60.
Grantham, July 1856 to October 1860.
Lampeter, 1856 to 1860.
Manchester, 1856 to 1860.

If you would wish to obtain these Observations, either for the Meteorological Society or the Meteorological Office, they are at your disposal.

Professor H. Mohn, Meteorological Institute, Christiania.

1. "Norsk Meteorologisk Aarbog" for 1867–73, (1874 is in the press). Distributed by the Secretary of the University, as also the following works:—
"Meteorologiske Jagttagelser i det sydlige Norge" 1863–66. "Det norske "Meteorologiske Instituts Storm-Atlas udgivet med Bistand af Videnskabs-"selskabet, Christiania, af H. Mohn," 1870. Pamphlets on Thunderstorms in Norway, on the Climatology of Norway, on Arctic Geography and Meteorology in "Forhandlinger i Videnskabs-selskabet i Christiania," 1867–74. "Bulletin du Nord," in conjunction with the Meteorological Institutes of Stockholm and Copenhagen.

2. Meteorological observations made at Christiania Observatory, vol. I., 1837–63:—
"Meteorologiske Jagttagelser paa Christiania Observatorium," 1864–67.
"Meteorologiske Jagttagelser paa fem Telegraph stationer ved Norges "Kyst. Forste og anden Aargang." (1861 and 1862.) Issued by C. Fearnley.

3. The observations made at Christiania Observatory from 1868 to the present time are in manuscript. An extract (barometer and temperature) is communicated monthly to the Meteorological Institute.

At the University Library there is an old series extending over many years, (part of which have been printed in the "Magazin for Naturvidenskaberne,") in the manuscript of M. Herzberg of Ullensvang (Hardanger). The number of years, the quality of the instruments, and the completeness, I know nothing about.

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At the Meteorological Institute there are in manuscript several series of old observations, some of them extending over several years. The nature of and the exposure of the instruments and the method of observing are not known.

4. The manuscripts of the University Library are not lent out. That can scarcely be permitted at the Observatory or the Meteorological Institute. They may be referred to on the spot; copies are only made for repayment.

5. See the "Norsk Meteorologisk Aarbog."

The Climatology of Norway in Professor N. Schübeler's "Die Planzenwelt Norwegens."

"Det Norske Almanak" for 1875.

A complete summary of the Climatology of Norway will, it is hoped, be published in the next few years.

R. H. Scott, Meteorological Office, London.

1. The full titles and names of publishers of all publications issued by this Office since it was placed under the management of the Royal Society Committee will be found contained in every publication, and a list is appended hereto. Those published by Admiral FitzRoy, prior to 1867, are specified in a Report to Parliament in 1866. ("Report of a Committee appointed to consider certain questions relating to the Meteorological Department of the Board of Trade.") This Office also issues to subscribers, Weather Reports and Charts (over 500) and hourly values of the records of its seven observatories which are also issued to various institutions.

2. The Registrars General for England and Scotland respectively have published quarterly returns from several stations in their Reports for a series of years. In addition the Observatories of Greenwich, Edinburgh, Oxford, Liverpool (now Bidston, near Birkenhead), Nottingham, and various other private institutions, publish independently.

3. A list of the principal unpublished observations possessed by this Office has been made for reference, and a copy is subjoined. No copies are lodged in any other place unless under conditions stated in No. 4.

4. The originals may be referred to at this Office or copies may be had by paying the cost of copying. The original documents are not lent out.

5. Monthly and quarterly means of the principal elements are published by the Registrar General (England), and by the Scottish Meteorological Society. The Meteorological Society (London), will also shortly publish observations taken at its own stations.

This Office has published five-day, monthly, and yearly means for its seven observatories, and from 1st January 1875 has commenced the publication of original observations at about 15 stations of the second order, and also monthly means from other stations. Full particulars will be found in the "Quarterly Weather Reports," and in the Annual Reports presented to Parliament.

The following papers may also be specially mentioned, Glaisher's "Mean Temperature of Greenwich," 1814–56, of which a later edition, extending to 1874, is I believe now in hand, and Buchan's "Temperature of the British Isles" published in the Journal of the Scottish Meteorological Society. A list of published and unpublished observations in the United Kingdom and its Colonies will be found in the Report of the British Association, 1873, Part I. pp. 495–522.

List of Publications, &c., issued under the Authority of the Meteorological Committee.

Official.

No.

1. Report for 1867. Presented to Parliament. 1*s.*
2. Instructions for Meteorological Telegraphy. 6*d.*
3. Fishery Barometer Manual. 6*d.*
4. Charts of Surface Temperature, South Atlantic Ocean. 2*s.* 6*d.*
5. Report for 1868. Presented to Parliament. 5*d.*
6. Report for 1869. Presented to Parliament. 10*d.*
7. Quarterly Weather Report for 1869.—Parts I. to IV. Price 5*s.* each. [Stanford.]
8. Barometer Manual. 1*s.* [Out of Print.]

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No.
9. Quarterly Weather Report for 1870.—Parts I. to IV. Price 5*s.* each [Stanford.]
10. Report for 1870. Presented to Parliament. 10*d.*
11. Contributions to our Knowledge of the Meteorology of Cape Horn and the West Coast of South America. Price 2*s.* 6*d.* [Stanford.]
12. Currents and Surface Temperature of the North Atlantic Ocean, from the Equator to Lat. 40° N. for each month of the year, with a General Current Chart. Price 2*s.* 6*d.* [Stanford.]
13. A Discussion of the Meteorology of the Part of the Atlantic lying North of 30° N. for the Eleven Days ending 8th February 1870. Price, with Book of Charts, 5*s.* [Stanford.]
14. Quarterly Weather Report for 1871.—Parts I. to IV. Price 5*s.* each. [Stanford.]
15. Report for 1871. Presented to Parliament. 10*d.*
16. Quarterly Weather Report for 1872.—Parts I. to IV. Price 5*s.* each. [Stanford.]
17. Report for 1872. Presented to Parliament. 1*s.*
18. Contributions to our Knowledge of the Meteorology of the Antarctic Regions. Price 2*s.* [Stanford.]
19. Quarterly Weather Report, 1873.—Parts I. to IV. Price 5*s.* each. [Stanford.]
20. Charts of Meteorological Data for Square 3. Lat. 0°-10° N., Long. 20°-30 W., and Remarks to accompany the Monthly Charts, which show the best routes across the Equator for each Month, &c. Price 20*s.*
21. Report of the Proceedings of the Meteorological Congress at Vienna. Price 1*s.* [Stanford.]
22. Report for 1873. Presented to Parliament. Price 4*d.*
23. Report of the Proceedings of the Conference for Maritime Meteorology held in London, 1874. Price 2*s.*
24. Instructions in the Use of Meteorological Instruments. Price 1*s.* 6*d.*
25. Quarterly Weather Report for 1874.—Part I.—January to March. Price 5*s.*
26. Report for 1874. Presented to Parliament Price 6*d.*
27. Charts of Meteorological Data for the Nine 10° Squares of the Atlantic which lie between 20° N. and 10° S. and extend from 10° to 40° W., with accompanying remarks. [*In the Press.*]

Non-Official.

1. Report to the Committee on the Connexion between Strong Winds and Barometrical Differences.—By Robert H. Scott, Director of the Office. 6*d.*
2. Report to the Committee on the Meteorology of the North Atlantic.—By Captain H. Toynbee, Marine Superintendent. 1*s.*
3. Report to the Committee on the Use of Isobaric Curves.—By Captain H. Toynbee, Marine Superintendent. 1*s.*
4. Routes for Steamers from Aden to the Straits of Sunda and back. Translated from a Paper issued by the Royal Meteorological Institute of the Netherlands. Price 6*d.*
5. On the Winds, &c., of the North Atlantic along the Tracks of Steamers from the Channel to New York. Translated from a Paper issued by the Deutsche Seewarte, Hamburg. 6*d.*
6. Report of the Proceedings of the Meteorological Conference at Leipzig. Price 1*s.*
7. Notes on the Form of Cyclones in the Southern Indian Ocean.—By C. Meldrum, Esq., M.A., F.R.A.S. Price 6*d.*
8. Report on Weather Telegraphy and Storm Warnings. Presented to the Meteorological Congress at Vienna. Price 6*d.*
9. Report of the Permanent Committee of the Vienna Congress for 1874. Price 1*s.* 6*d.*
10. On the Physical Geography of that part of the Atlantic which lies between 20° N. and 10° S. and extends from 10° to 40° W. A Paper read before the British Association at Bristol, in August, 1875, by Captain Toynbee, F.R.A.S. and F.R.G.S., Marine Superintendent. Price 1*s.* 6*d.*

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List of the *principal unpublished* Materials in the Meteorological Office.

Table I.—Marine.

Ocean.	District discussed.	Nature of Work done.	Remarks.
North Atlantic - (1)	Lat. 0° to 60°	Wind data in 5° squares. Direction and force for each month. Maury's observations combined with those of Meteorological Office.	This work was done by Admiral FitzRoy; and the middle months of each quarter were published in 1859.*
,, - - (2)	,, 40 to 60	Sea temperatures and currents, extracted from Meteorological Office logs, in 5° squares.	Used by Admiralty for Physical Charts.
,, - - (3)	,, 0 to 60	Observations of barometer, thermometer, wind and weather, specific gravity, &c. grouped in Data books for each 5° square.	Collected by Admiral FitzRoy; scanty.
,, - - (4)	,, 0 to 60	*The observations contained in item (1) from Meteorological Office logs only, grouped in a tabular form.	Printed but not published.
,, - - (5)	,, 0 to 20	All meteorological observations grouped in 1° squares for each month.	Collected in data books. In the press.
South Atlantic - (6)	,, 0 to 10	,, ,, ,, ,,	,, ,, ,,
,, - - (7)	,, 0 to 60	Wind data corresponding to item (1) - - -	Collected, &c. by Admiral FitzRoy.
,, - - (8)	,, 0 to 60	Observations of barometer, &c. corresponding to item (3)	Collected, &c. by Admiral FitzRoy; scanty.
,, - - (9)	,, 0 to 60	Currents, grouped in a table of 5° squares for each month.	
,, - - (10)	,, 0 to 60	*Wind data corresponding to item (4) - - -	Printed but not published.
North Pacific - - (11)	Whole surface	Meteorological data. Three equidistant observations daily, grouped in 5° squares for each month, with totals and averages of observations.	Part for Vancouver's Island published; part for seas of China and Japan in the press.
South Pacific - - (12)	,,	,, ,, ,, ,,	A portion (Cape Horn and west coast of South America) published in No. 11.
Indian Ocean - - (13)	,,	Observations as in item (3) - - - -	Collected by Admiral FitzRoy.
Mediterranean and other inland seas. (14)	,,	,, ,, - - - -	,, ,,
All Oceans - - (15)	- - -	Collection of remarkable passages, gales, ice, &c. from Meteorological registers.	Printed but not published.
,, - - (16)	- - -	Collection of currents, from Meteorological Office and Admiralty logs (eight MS. vols).	By Admiral FitzRoy.
Southern Atlantic and Indian. (17)	Cape of Good Hope	Observations corresponding to item (5) - - -	Collecting into data books.
Bay of Bengal and Arabian Sea. (18)	- - -	,, ,, ,, - - -	,, ,,
—— - - (19)	- - -	Observations on the temperatures of the sea, &c. at English and Irish lighthouses, &c.	From March 1875 continuing.

* N.B.—This statement does not take into account the undigested observations not yet extracted from the registers.

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Table II.—British Islands.

Station.	Nature of Work done.	Date.	Remarks.
7 Self-recording Observatories:—			
Aberdeen - - -	Hourly tabulations of barometer, thermometer, and wind - - - - -	Since 1868.	5-day means of barometer and thermometer, and continuous curves, published in Quarterly Weather Report. Hourly observations printed by lithography from 1874.
Armagh - - -			
Falmouth - - -			
Glasgow - - -			
Kew - - - -			
Stonyhurst - -	and rainfall - - - -	Since January 1871.	
Valencia - - -			
7 Anemograph Stations:—			
Alnwick - - -	Hourly tabulations of direction and velocity -	From March 1870.	None yet published, except Orkney for six years ending 1868.
Halifax - - -		„ January 1871.	
Holyhead - - -		„ August 1869.	
*Kensington - -		„ September 1869.	
Orkney - - -		„ July 1869.	
Seaham - - -		„ November 1872.	
Yarmouth - - -		„ September 1869.	
Oban - - - -	Monthly abstracts made by Captain Thomas, R.N., during Admiralty Survey.	1858–1865 - - -	Some of these means were published by the Scottish Meteorological Society.
Miscellaneous - - -	Observations received monthly from about forty stations distributed over the British Isles, and specified in annual reports of the Office.	- - - - -	None *yet* published; but the observations are to some extent utilized in writing the Chronicle of the Quarterly Weather Report. Publication for some stations commenced for 1873 in the Quarterly Weather Report.
	These stations are in addition to the *telegraphic* reporting stations, and commence at various dates.	Subsequent to 1867.	
„ - - -	†Synchronous observations taken at 0h. 43 pm. at about 60 stations in the United Kingdom.	From February 1874 -	Copies supplied to Washington for publication by the Chief Signal Officer.

* Two years only.

† A considerable series was also collected by Admiral Fitzroy in 1857 and 1859–60, and the materials were partly utilized in drawing maps for weather study.

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Table III.—Foreign and Colonial.

Station.	Nature of Observations.	Date.	Remarks.
Angra do Heroismo (Azores), Funchal (Madeira).	One observation daily. Readings corrected and reduced in millimetres and centigrade.	Since January 1870.	Means from these stations are published in Portugal.
Apia, Samoa (Navigators' Islands).	Meteorological observations unreduced. One observation daily.	Twenty months, not continuous, in 1862–1865.	By J. C. Williams, Consul.
Ascension - -	Hourly observations with monthly means of barometer and thermometer. Anemometrical observations and reductions.	October 1863 to October 1865.	By Lieutenant Rokeby. Preparing for publication with marine work for Equatorial District. (*See* item 5.)
Bangkok (Siam) - -	Two observations daily, with monthly means -	January to December 1858	By Dr. Campbell, attached to H.M. Consulate.
	Three observations daily, no means deduced -	1859–1861 } 1863–1867 } - -	There are several interruptions in the series.
Bermuda - -	Anemometrical observations (not all tabulated)	Since 1868 - -	Observations for previous years, so far as reliable, published in the Quarterly Weather Report, 1872.
Ceylon, Point de Galle -	Two observations daily, and monthly means -	From January 1869, continuing.	By D. Blyth, Master Attendant.
Corfu - - -	Mean, maximum, and minimum readings of barometer and thermometer.	October 1859 to September 1860.	
Fiji - - -	Bi-daily observations of barometer, thermometer, rain, &c.	January 1865 to June 1867	By Mr. Binner, Wesleyan Training Master.
Gibraltar - - -	Two observations daily, with monthly means -	Since June 1870, continuing.	The original observations are supplied to Army Medical Department.
Lighthouses :—			
* Cape Pembroke (Falklands).	Observations of barometer, thermometer, wind, &c., made several times daily.	From July 1859, continuing.	
* King George's Sound (2)	- - - - - - -	July 1861 to Dec. 1869.	
Abaco (Bahamas) -	- - - - - - -	March 1858 to June 1860 July 1871, continuing.	
Cay Sal (Bahamas) -	- - - - - - -	March 1858 to June 1860. July 1871, continuing.	Not very trustworthy.
Great Isaacs (Bahamas)	- - - - - - -	August 1859 to Jan. 1860.	
Gun Cay „ -	- - - - - - -	Jan. 1858 to July 1859.	
Inagua „ -	- - - - - - -	July 1871 to June 1872.	
Sombrero - -	- - - - - - -	September 1867, continuing.	
Natal (Maritzburg) -	Complete observations three times daily; monthly averages are made out.	January 1860 to February 1866.	By Dr. R. J. Mann, F.R.A.S., January 1858 to March 1859 published in 5th Number of Meteorological Papers.
Tahiti - - -	Means of observations taken four times daily. The measures are French.	Jan. 1858 to June 1860.	Extracts from the "Messager de Tahiti."
Trinidad - - -	Observations twice daily of barometer, thermometer, wind, &c. Monthly means are deduced.	February 1862 to June 1864.	Mr. Crüger, the observer, published a pamphlet embodying some of the results.

* The monthly averages for Cape Pembroke and King George's Sound for the barometer have been obtained for seven years.

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METEOROLOGICAL SOCIETY, LONDON.

1. *a.* Reports of the Council of the British Meteorological Society read at the Annual General Meetings 1851 to 1861, 10 numbers. London. Taylor and Francis.

b. Proceedings of the Meteorological Society, Vols. I to V., 1861 to 1871. London. Taylor and Francis.

c. Quarterly Journal of the Meteorological Society, Vols. I., II., 1872 to 1875. London. Taylor and Francis, and Williams and Strahan.

3. The Society possesses the MS. observations of the late Miss C. Molesworth, made at Cobham, from 1823 to 1867, and of the late Mr. A. Edwin made in London from 1815 to 1871.

4. The above unpublished MS. observations are preserved in the Society's library, and can be referred to. Every facility will be allowed for making copies.

5. *a.* "On the mean temperatureof every day from all thermometrical observations taken at the Royal Observatory, Greenwich, from the year 1814 to the end of 1863," by James Glaisher, F.R.S.

Published in the proceedings of the Meteorological Society, vol. II.

b. "On the fall of rain on every day of the year from observations extending from 1815 to 1869," by James Glaisher, F.R.S. Proceedings, vol. V.

c. "Average height of the barometer in London for 83 years" by H. S. Eaton, M. A. Proceedings, vol. I.

d. "On the direction of the wind at the Royal Observatory, Greenwich, in the 20 years ending December 1860," by James Glaisher, F.R.S. Proceedings, vol. I.

Ditto, in the 10 years, ending December 1870. Quarterly Journal, vol. I.

Rev. BENITO VINES, S.J., Real Colegio De Belen, Havana.

I have the honour to acknowledge the receipt of the Circular of the Permanent Committee of the Meteorological Congress at Vienna, dated 5th May 1875. The wish of establishing any Meteorological stations in some places of the Antilles, according to the wishes of the Committee, was the reason I had to defer the answer. It is not easy to perform it if we fix in the mind the circumstances which have disturbed the island, nevertheless I expect to be able to get observations from Porto Rico, Sancti Spiritus, and perhaps from Santiago of Cuba, and in this case I would publish them, together with the observations at Havana, according to the model given by the same Committee, Appendix F.

The publications of this Observatory, you know them all, for you have the complete collection from the year 1858.

The instrument used you will find shortly described in the publication of the year 1860, in the "Memoria sobre la marche del Barometro," &c. Besides this Secchi's meteorograph is acting in this Observatory since the year 1873. If any more explanations are wanted I will send them to you.

As I wish to conform in everything to the resolutions of the Congress, and to the wishes of the Permanent Committee, let me know whether after present year it would be sufficient to give in the publication the result of the ten observations made daily, as has been done hitherto in this Observatory, or will it be necessary to reduce them to three, according to the form of Appendix F.

Prof. H. WILD, Central Physical Observatory, St. Petersburg.

The questions of Circular "I" are already mostly answered by our publications. Claver's Catalogue in the 2nd Vol. of the new "Repertorium für Meteorologie" gives complete information as to the published Meteorological Observations in Russia. The observations existing in manuscript in the archives of the Observatory are either so defective or incomplete that they are not worth general consideration, nevertheless we intend to publish a list of them also. Copies of the same can at any time be had from the Observatory, and payment is only required when their extent is considerable.

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APPENDIX II.

Meteorological Office, 116, Victoria Street, London,
February 19th, 1876.

SIR,

THE Permanent Committee of the Meteorological Congress of Vienna have the honour to announce that they intend to hold their next meeting at the Meteorological Office in London, in Easter week, commencing April 18th.

In May 1875, we had the honour to address to you a Circular, pursuant to instructions received from the Vienna Congress, requesting you to furnish the Permanent Committee with certain particulars relating to your Meteorological organisation.

Several of the gentlemen to whom the Circular in question was addressed have not as yet sent their replies to it, and we therefore beg to enclose another copy, with the request that you will furnish us at your earliest convenience with your reply, if you have not already done so; or if you have, that you will be kind enough to make any further observations, bearing on the contents of the Circular, which may occur to you, as such information will be of material aid to the Permanent Committee in their deliberations.

We would wish to ask your opinion on the following points, which are contained in the Circular in question.

1. Do you approve of the forms recommended by the Permanent Committee for publication of the results from stations of the Second Order?
2. To what extent have those forms been introduced into the publications of your country or organisation?
3. If the forms in question have been adopted, have you any observations to offer thereupon, or any alteration therein to suggest?
4. The Permanent Committee having resolved to forward the publication and the sale of the Synchronous Charts published by M. Hoffmeyer, we should be glad to know for what number of copies you are prepared to subscribe, and whether or not you are prepared to subsidize the undertaking by a pecuniary contribution, and if so, to what amount?
5. Professor Cantoni has communicated to us that the Italian Government has been pleased to intimate its readiness to invite the countries which were represented at Vienna to attend a Meteorological Congress in Italy, in the autumn of 1877, and we are therefore to inquire whether or not you see any objection to the postponement for one year, of the meeting of the International Congress, fixed for 1876 by resolution of the Vienna Congress,—in respect of Question 28 (carrying out the decisions of the Congress).

We take the liberty to state that, if you do not object, we shall consider this proposal (No. 5) as accepted.

Your obedient servants,

BUYS BALLOT, President.
ROBERT H. SCOTT, Secretary.

SUMMARY of CONTENTS of REPLIES.

Question 1.—"*Do you approve of the forms recommended by the Permanent Committee for publication of the Results from Stations of the Second Order?*"

Austria -	Dr. Lorenz.—Yes.
	Professor Jelinek.—Yes, with some modifications as noted under Question 2 (p. 50).
Bavaria - -	Professor Ebermayer.—General approval.
Canada - -	Dr. Kingston.—Yes.
Denmark -	Captain Hoffmeyer.—Yes.
Great Britain and Ireland -	The Meteorological Office.—Yes.
	The Meteorological Society.—Yes.
	The Scottish Meteorological Society.—No. (*See* p. 54.)

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Holland - - Professor Buys Ballot.—Yes, for the international stations.
Italy - - Professor Cantoni.—Yes, for the international stations, as explained below.
Norway - - Professor Mohn.—Yes.
Russia - - Professor Wild.—Yes.
Saxony - - Professor Bruhns.—Yes.
Spain - - Dr. Aguilar.—Prefers to leave the matter to the decision of a future Congress.
Switzerland - Dr. Billwiller for Professor Wolf.—Yes, with a few modifications; locally necessary.
Turkey - - M. Coumbary.—Yes.

Question 2.—"*To what extent have these forms been introduced into the publications of your country or organisation?*"

Austria - - Professor Jelinek.

I.—*Individual Observations.*

a. Tension of vapour not published.
b. Wind force estimated from 0–10.
c. Cloud notation not followed.
d. Time of hydrometeors omitted.

II.—*Results.*

a. Columns for mean maximum and minimum omitted.
b. Absolute humidity not published.
c. Mean cloudiness, only, given, for want of space.
d. Number of days of cloud and clear sky not given, for want of space.

Bavaria - - Professor Ebermayer.—Not introduced as yet.
Canada - - Dr. Kingston.—Will probably adopt the form in future.
Denmark - Captain Hoffmeyer.—For 1874 and 1875 observations have been published from 15 stations, nearly on the form recommended. In 1876 closer conformity will be made.

Great Britain and Ireland { The Meteorological Office } For 1874. 1 Station, Form A.
{ The Meteorological Society } 9 Stations, Form B.
" " " For 1875. 9 Stations, Form A.
" " " 26 Stations, Form B.
For 1876. These numbers will be increased, especially as regards Form B.
The Scottish Meteorological Society. Not adopted; *see* reply to Question 1.

Holland - - Professor Buys Ballot.—Adopted for Leeuwarden, Flushing, Maestricht.
Italy - - Professor Cantoni.—As explained below.
Russia - - Professor Wild.—Generally adopted in 1874, and entirely so in 1875.
Saxony - - Professor Bruhns.—Adopted since 1875.
Spain - - M. Aguilar.—*See* reply to question 1.
Switzerland - Dr. Billwiller.—*See* reply to question 1.
Turkey - - M. Coumbary.—Hopes to introduce them.

Questions 3.—"*If the forms in question have been adopted, have you any observations to offer thereupon, or any alteration therein to suggest?*"

Austria - - Dr. Lorenz.—No suggestions to make.
" - - Prof. Jelinek.—Adheres to the opinion that it would be better to give each element in Table B. in separate tables, containing all stations and all months of the year. (*See* reply to question 2.)

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Canada - -	Dr. Kingston.—1. Prefers separate columns for rain, snow, &c. 2. Would have a column for velocity of wind. 3. Columns for daily means of some elements are desirable. 4. Provision is required for showing the average force or velocity in each month, for separate hours as well as for the hours combined.
Denmark -	Capt. Hoffmeyer.—Unnecessary to repeat latitude and longitude at the head of every monthly table.
Great Britain and Ireland -	The Meteorological Office.—No suggestions to make. The Meteorological Society.—Prefer to give the dew point instead of vapour tension.
Holland - -	Prof. Buys Ballot.—*See* below.
Italy - -	„ Cantoni.—*See* below.
Russia - -	„ Wild.—No suggestions to make.
Saxony - -	„ Bruhns.—No suggestions to make.
Switzerland -	Dr. Billwiller.—*See* reply to question 1.

Replies.

Dr. C. Jelinek, Central Institution for Meteorology, &c., Vienna.

I have the honour to submit the following reply to the Circular No. 4, issued 19th February 1876, by the President of the Permanent Committee and by you.

To 1–3.—The Circular speaks only of *results* from stations of the Second Order. Our Annals contain besides these—

(*a.*) Individual observations taken at a selected number of stations, this number being 10 in 1875, 15 in 1876.

The Permanent Committee at their meeting in Utrecht have also fixed a form for these individual observations.

(*b.*) Results of Stations of the Third Order, *i.e.*, not provided with a barometer or a psychrometer. For such stations the Permanent Committee have not recommended a definite form.

I.—*Individual Observations.*

Our publication in the "Jahrbuch" differs from the form recommended by the Permanent Committee in the following points:—

1. The tension of vapour (absolute humidity) is not published, firstly for want of space, secondly because it may be deduced from the indications of the temperature and relative humidity, and, finally, because the theory that the tension of vapour may be subtracted from the total pressure of the atmosphere to get the pressure of dry air, has lost more and more of its adherents.

2. We have retained the scale 0 to 10 for the force of wind. Our stations are not provided either with cup-anemometers nor with Wild's anemometrical apparatus; they are therefore without means of giving the velocity of wind in metres per second.

3. In the column "Clouds" it was not possible to introduce the exponents recommended by the Meteorological Congress, with regard to our printing arrangements.

4. For the same reason the column headed "Remarks" is somewhat narrow, and it has not been possible to introduce the signs for indicating the time at which the several hydrometeors have taken place.

II.—*Results of Stations of the Second Order.*

1. There are wanting the columns of the mean minima and maxima.

There are few stations in Austria provided with maximum and minimum thermometers. We are trying to augment their number.

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The absolute minimum and maximum observed by maximum and minimum thermometers (generally Six's thermometers by Casella) at some stations, are published in a special table.

2. The absolute humidity is not published; reasons the same as above.

3. For the cloudiness, only the means of three hours are given, not these themselves; one column instead of four, through want of space.

4. The number of clear and totally clouded days is not given, through want of space.

III.—*Results of Stations of the Third Order.*

1. The pressure of the atmosphere is wanting because these stations are not provided with barometers.

2. The temperature is given as for the stations of the Second Order.

3. The absolute and the relative humidity are wanting, because these stations have no psychrometers.

4. Cloudiness; only the mean of the three hours given.

5. Number of days with hail, not given.

6. Number of days with strong winds, not given.

All this for condensing the table, so that the results may be printed on the fourth part of a page.

As to question No. 3 more especially, I beg leave to express my opinion that I still adhere to such an arrangement of the meteorological material as would allow of the single meteorological elements, atmospheric pressure, temperature, humidity, and rain being given in separate tables containing all stations and all months of the year.

As we have found this form very useful we shall continue to conform to the regulations of the Congress and of the Permanent Committee, but we shall add a few tables formed after the old system, especially for the temperature and the rain.

We should consider it very useful if other Central Institutes could be induced to publish analogous tables, especially one for the mean temperature, and a second for the quantity of rain.

Question 4. The Central Meteorological Institute of Vienna has, till now, not subscribed for a determined number of copies of Hoffmeyer's Atlas, but only collected and forwarded to Captain Hoffmeyer the subscriptions addressed by institutes and private persons to our establishment.

We are prepared to ask our Government to subsidize the undertaking, either by a pecuniary contribution, or, what we should prefer, by subscribing to a definite number of copies of the Atlas.

If the Permanent Committee will form a plan for subsidizing M. Hoffmeyer's undertaking, and assign to every country the number of copies, or an equivalent amount of pecuniary contribution, I can express my strong belief that the Austrian Government will grant the necessary means for this not very considerable outlay.

Till now, 40 subscribers, partly Institutes, part private persons, have been won to the undertaking by our establishment.

Question No. 5. I have already, in a previous letter, expressed my adhesion to the postponement of the Congress to autumn 1877.

Yours, &c.,
C. JELINEK.

Ministry of Agriculture, Vienna.

YOUR Circular of the 16th February 1876, No. 4, invites me to reply to five questions, and I do so with the present.

I represent only the Agricultural part of Climatology, whilst M. Jelinek, as Director of the Central Office for Meteorology in Austria, represents officially the whole of our Meteorology. I must therefore leave to M. Jelinek to answer the second question, and confine myself to the others.

I. I approve the forms mentioned in the question.

III. I have neither observations to offer, nor any alteration to suggest.

IV. Our Ministry of Agriculture has already subscribed for four copies of the Synchronous Charts of M. Hoffmeyer, and cannot subscribe for a greater

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number; the whole number of subscribers in Austria you will have from M. Jelinek.

V. I consent to the postponement of the Meteorological Congress for one ear, and holding it in Italy.

Dr. E. Ebermayer, Royal Academy of Forestry, Aschaffenburg.

I have the honour to reply as follows to your esteemed communication of the 19th February 1876.

1. As you are already aware from a former communication, the Royal Bavarian Ministry of Instruction has determined, in consequence of our Report on the proceedings and results of the International Congress at Vienna, to found a Central Meteorological Institute in Munich, and has requested MM. von Lamont, Lommel (of Erlangen), and myself to prepare a detailed plan. This has been submitted for the consideration of the Bavarian Academy of Sciences, and, after being tested by the physical and mathematical section, it was recommended by the Royal Academy to the Ministry of Instruction to be carried out.

In consideration of the present state of our Lower Chamber the Government, however, considered it prudent not to include the necessary sum in the present budget, but in the next financial period.

It is greatly to be regretted that, on these grounds, the re-organisation of the meteorological service in Bavaria, which is so much desired by all men of experience, has been again deferred.

2. The forms adopted by the Permanent Committee for the publication of results will be adopted from the year 1877 at the stations under my direction.

3. I possess one copy of Hoffmeyer's Synoptic Charts; when the organisation of the Central Meteorological Institute of Bavaria takes place, other copies will doubtless be subscribed for, and there will then also be a prospect of a subsidy.

4. I am glad that the Meteorological Congress in the autumn of 1877 is to be held in Italy.

G. T. Kingston, M.A., Meteorological Office, Toronto, Canada.

To the questions in Circular, dated 19th February 1876, I have to reply as follows:—

I. On the whole, I approve of the forms for the publication of results at stations of the Second Order.

II. Hitherto in publishing results from Canadian stations, I have, for the most part, adopted the practice of showing in one view the *same* element at *different* stations, but it is likely that for some stations I shall also adopt the form recommended, in which all the elements at one station are shown together.

III. Although as yet I have not used the forms recommended, I venture to make some remarks on them:—

First, with respect to the plan for the publication of the actual observations,—

(*a.*) I consider that, instead of a single column for rain, there should be one column for rain, one for snow, and one for the total of rain and the water to which the snow is equivalent.

(*b.*) In addition to the single column for the direction and force of the wind I would desire another to contain the velocity, in order to meet the cases where stations, although in other respects of the Second Order, are provided with anemometers.

(*c.*) Columns for the daily means of some of the elements are desirable.

With reference to the plan for publishing monthly and yearly results, I would add to the preceding remarks (as far as they are applicable) that some provision is required for showing the average force or the average velocity in each month for the separate hours as well as for the three hours combined.

IV. I intimated some months ago to M. Hoffmeyer that I would be pleased to receive ten (10) copies of the Synchronous Charts, and I have since received a portion of those published.

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Captain N. HOFFMEYER, Meteorological Institute, Copenhagen.

I have the honour to send the following replies to the questions put by Circular 4.

1. We approve in principle the form for publications proposed by the Permanent Committee.

2. In the Annals of the Danish Meteorological Institute for 1874, the observations of 15 stations have been published in nearly complete accordance with this form. The Annals for 1875 are already in course of publication, but in those for the year 1876 we are ready to conform still more strictly to the resolutions of the Committee,

3. We remark merely that it would perhaps not be necessary to repeat at the head of each monthly table for the same station the height, longitude, latitude, and year.

4. The Danish Institute is ready to subscribe for 15 copies of the "Daily Synoptic Charts" and the Danish Government is willing to take into consideration, later on, the means of covering an eventual deficit.

5. The Danish Government makes no objection to the convening of the second International Congress being deferred till the autumn of the year 1877.

R. H. SCOTT, Meteorological Office, London.

1–3. The Meteorological Office approves of the forms recommended by the Permanent Committee and has introduced them into use for the stations of the Second Order in connexion with it.

4. The Meteorological Office has hitherto subscribed for such a number of Captain Hoffmeyer's Charts as it was able to dispose of to subscribers. This number has been about 25. For the future it will subscribe for 50 copies, and will supply copies of any observations in its possession for the Atlantic Ocean for the epochs at which the charts are drawn, during the year 1875 at least.

The Meteorological Committee are not prepared to grant a pecuniary subsidy in any other form than that of subscription for copies, as their powers would not extend so far as to allow them to do so.

5. The postponement of the meeting of the Congress till 1877 seems desirable.

The METEOROLOGICAL SOCIETY, London.

1. Yes.

2. They will be used for the publication of observations in the Society's Journal.

3. No; except that perhaps it would be better to give the Dew Point instead of the Tension of Vapour.

4. The Society already subscribes for one copy of Captain Hoffmeyer's Synchronous Charts, but is not prepared in any way to subsidize the undertaking by a pecuniary contribution.

5. No objection to holding the Congress in 1877.

Professor BUYS BALLOT, Royal Meteorological Institute, Utrecht.

I have no real objection to the proposed forms but this, that these publications should be given, as much as possible, monthly, and only yearly for such places as cannot possibly send in their observations in time.

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Professor J. CANTONI, Royal University, Pavia.

I thank you for your obliging letter and Circular No. 4 (19th February 1876).

As to the questions put by Nos. 1–3 of this Circular, I confirm what I have said in my letter (Appendix D.) in the Report of the Permanent Committee on the meeting at Utrecht; viz.: that for International publications, I prefer the form which I have given in the "*Bollettino decadico*" of 1876 for "*Meteorologia Italiana*," to that adopted by MM. Wild and Jelinek, and I reserve the development of the considerations which seem to support my opinion, for the meeting in London.

As to M. Hoffmeyer's Synoptic Charts this Ministry has already subscribed for 12 copies, and perhaps the Ministries of Marine and Instruction will also subscribe.

Professor H. WILD, Central Physical Observatory, St. Petersburg.

In reply to the five questions put by the Circular of our Permanent Committee, dated 19th February, I have to state as follows:—

1. That I entirely approve of the new form proposed for publication of the observations of stations of the Second Order.
2. This form was, in its essential parts, already introduced in the publication of the observations in Russia in the year 1874, just issued, and for the observations of the year 1875 and their publication it has been completely adopted.
3. I have no change to propose in this form.
4. I have subscribed for 30 copies of M. Hoffmeyer's charts. A further pecuniary support of this undertaking might perhaps be effected by an increased yearly contribution to the expenses of the Committee.
5. I entirely concur that a second Meteorological Congress should be convened in the autumn of the year 1877 in Rome.

Professor C. BRUHNS, Observatory, Leipzig.

I have already sent my reply to the circular of the 19th February to M. Buys Ballot, as follows:—

To question 1, as to whether I approve of the publications, I reply "Yes."

2. Since 1875 everything has been here published in accordance therewith.
3. I have no remarks to make.
4. I subscribe for six copies of Capt. Hoffmeyer's charts.
5. I concur with the holding of Meteorological Congress in Italy, and would wish it to be April 1877 or 1878.

A. BUCHAN, M.A., Scottish Meteorological Society, Edinburgh.

As one of the two Delegates of the British Government to the Meteorological Congress at Vienna, I have to draw your attention to what appears to me to be an irregularity in the proceedings of the Permanent Committee, appointed by the Congress, at their meeting at Utrecht in September 1874.

At Vienna the question of observations for international purposes of Meteorology was discussed, but the idea was not very cordially entertained: 10 voting for the proposal, 8 against it, while 11 took no part in the division.

At the same meeting a form for publication, which had been prepared by Dr. Köppen, of St. Petersburg, was put into the hands of Delegates. With reference to this form, I pointed out to the Congress that, as one of the Delegates of the British Government, I was precluded from approving of or sanctioning any such form, owing to the terms of my appointment as Delegate, which distinctly stated that I "should abstain from pledging Her Majesty's Government in any way;" now, by an agreement with the British Government, the Scottish Meteorological Society supplies meteorological information to the Registrar General for Scotland, on a form which had been agreed on. I added that I could not therefore agree to any form till it had been submitted to the Scottish Meteorological Society and approved by them and the British Government.

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It was chiefly to meet this objection that the following proposal was made and agreed to:—"That the best form of publication for the stations selected "for international objects should be determined by the Permanent Committee "in consultation with (nach Anfrage) the Directors of the Central Institutes, "and that it should be recommended for general adoption, &c." If this resolution had not been adopted, I should have opposed altogether the handing over to the Permanent Committee any such matter, simply on the ground of possible complications which might arise to the Scottish Meteorological Society.

The Permanent Committee met in September 1874, and adopted a form of publication, without apparently consulting the other Delegates of the Vienna Congress, certainly without consulting the Scottish Meteorological Society. In other words, the Permanent Committee did not give attention to that requirement of the remit from the Vienna Congress, which made it necessary for them to consult the Directors of the Central Institutes before coming to a conclusion on this matter.

I am directed to say that the Council of this Society are very desirous to forward in every way in their power the progress of international Meteorology, and that their desire is in no way affected by the omission on the part of the Permanent Committee to consult the Council before resolving on a form of monthly resumés for international purposes.

But the Council have felt and still feel great difficulty in the matter, inasmuch as, in so far as regards the observations themselves, no provision has been made by the Permanent Committee for establishing uniformity as regards the times, modes, and conditions of observing, which was the chief aim of the Congress to bring about; and besides, the form itself, being in several important respects very defective, must soon undergo modification.

Under these circumstances it appears to the Council of this Society that any action in this matter is premature, till such uniformity has been arranged and understood by all parties; and they cannot see that as regards international Meteorology anything but evil will result from observations in different countries when made at different times and with instruments differently placed and protected.

I am, therefore, desired by the Council to suggest that the matter of international observations should be held in abeyance until all parties who are interested have an opportunity of having their views fully made known, with a view to a definite line of action being resolved on.

A. BUCHAN, ESQ., M.A., (second letter), Scottish Meteorological Society, Edinburgh.

My letter of the 15th inst. renders it unnecessary to answer a number of the queries you refer to.

I hope to be able to-morrow to send the President, as requested, answers to several of the queries of Appendix E.

The Council regret that, owing to the state of the funds, it has *hitherto* been out of their power to subscribe for Capt. Hoffmeyer's Charts.

But at the General Meeting of the subscribers of the Society, held in February 1875, the Council very strongly recommended the Charts to the members.

A. AGUILAR, Astronomical Observatory, Madrid.

In reply to your Circular letter of the 19th February, I am sorry that I cannot be as explicit as I should wish, and I am of opinion that the questions which you put can only be definitely solved in the next Congress.

I neither give nor refuse my approval of the form recommended by the Permanent Committee for the publication of observations at stations of the Second Order, not having been able to introduce this form here, and consequently not knowing the improvements of which it might be susceptible.

Neither can I tell you for what number of copies of M. Hoffmeyer's Synchronous Charts I can subscribe for; I could only take a single copy with the ordinary resources at the disposal of this Observatory, and to ask for extra

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funds on their account, it would be necessary that the invitation should come from the Permanent Committee, when inviting the various nations to take part in the Congress, stating clearly that their Delegates should be authorised to propose the pecuniary contribution which each country should make towards the publication of works to be produced by joint co-operation.

There is no difficulty on my part to holding the Congress next year at Rome.

Dr. R. Billwiller, Swiss Central Meteorological Institute, Zürich.

M. Plantamour has handed us your two Circulars of 5th May 1875 and 19th February 1876.

The points 1–3 of your last letter are answered in our monthly publications; we have only introduced such modifications into the form as the peculiarities of our stations rendered necessary, as, *e.g.*, the addition of the normal temperature for each day, and of the monthly means of the elements deduced for many years, on account of the frequently considerable altitude of the stations.

4. We have not yet been able to do more for Mr. Hoffmeyer's undertaking than to collect subscribers in our country. We have only found six hitherto.

We agree to point 5.

A. Coumbary, Imperial Meteorological Observatory, Constantinople.

In compliance with the Circular dated 19th February last, which you sent me, I have the honour to forward the following replies to the various questions.

The arrangements made by the Permanent Committee for everything concerning the publications for stations of the Second Order are excellent, and I am using every effort to make our system conform thereto. The service at our stations being performed by telegraph officials, we cannot at present require of them an increase in the number of Meteorological observations which they take daily, without injuring the telegraphic service. At some stations, however, I have succeeded in inducing their chiefs to make observations twice a day, At Beyrout, Professor van Dyck having offered to take observations three times a day, this station entirely fulfils the requirements of the Permanent Committee.

With regard to the publication of M. Hoffmeyer's charts, I subscribe for two copies at present. As to subsidizing the publication of these charts, I should like to know what other countries have done in this respect, so that I may make up my mind.

I have no objection to the Congress, which should have been held this year, being deferred till next year; it seems to me that this delay cannot but be useful, for it will give time for the better study of certain questions which will be brought before the Congress.

E. J. Stone, F.R.S., Royal Observatory, Cape of Good Hope.

I reply to your circular as follows:—

The Meteorological observations made here 1841–1846, under the superintendence of Wilmot, you have in your hands for distribution (*i.e.* in the Meteorological Office).

The observations made here from 1841–1870 were discussed by me and the results published 1871, March 22nd. I presume you have copies. If copies of this work are wanted I could probably supply a few.

The observations 1871–1875 have consisted of readings of the barometer dry and wet bulb thermometers, maximum and minimum thermometers, Robinson's anemometer, and rain-gauge. A self-registering direction and pressure anemometer. The observations are made at 0h. 6h. 12h. and 18h. and at 1h. 45m. for comparison with the Washington results.

I have been too much occupied with other work to pay any great attention to the Meteorological work, and the only changes I have introduced have

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been the distribution of hours, which is partly dependent upon the convenience of our astronomical observer and the establishment of an additional set of meteorological instruments in the open air, under, what I believe, is for some reason or other called the Glaisher Stand. The old instruments are still read. They are placed in a crib before a window in the Transit Circle Room towards the North. The position is free from reflected heat of the sun, but the circulation of air around the instruments is much impeded by the buildings.

The results 1871–1875 will probably be appended to our next astronomical volume.

In addition to the Observatory Observations, observations were made 1861–1867 at certain stations over the colony under the direction of the Commission. These results have been published, and I forward copies. The Commission was re-organised in 1874, and is now at work. The whole of the stations selected are not at present provided with instruments, but the observations made under the scheme 1875, June—to the end of the year, are now being prepared for press. The observations are generally only taken twice a day at 8 a.m. and 8 p.m., hours selected to suit the general convenience of the observers who are volunteers. Before long I hope to see Meteorological observations made at these two hours at all the ports in South Africa.

At all the towns and in several of the outlying places our great difficulties have been to get any one to make *regular* observations, and to get barometers to stations. The breakage in the way of instruments has been serious, and I ordered, when in England, syphon barometers, graduated on the glass tubes and merely fixed to a wooden frame, for our use. These barometers appear to bear rough usage and are accurate and cheap.

You must excuse my not entering more fully in the points raised in your Circulars. I have not had the time necessary to give much value to my opinions upon the points raised, and in my own Meteorological work I have followed very much in the steps of the Greenwich work, with which I was best acquainted when I came here.

APPENDIX III.

(1.) Copenhagen, 7th April 1876.

Since the Barometric Gradient is beginning to be used more and more in Meteorological investigations, it seems to me that it would be very desirable to have an international definition of it, so that the data referring to this element may be quite comparable.

I therefore venture to propose to the Permanent Committee to establish such a definition as shall embrace both the direction and the amount of the gradient.

As to direction, I think there is already a sufficiently general agreement, for instance a gradient to the North signifies that the atmospheric pressure is lower in the north than in the south.

As to the amount, there are, on the contrary, very different expressions.

I shall not make any proposal to this effect, but if the Committee come to any agreement on an international method of expressing the relation between the decrease of the pressure of the air and the distance, I will venture to observe that the publication of a table will greatly facilitate the calculation of this relation and its general introduction into meteorology.

N. Hoffmeyer.

To the Permanent Committee
of the Vienna Congress.

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(2.) COPENHAGEN, 13th April 1876.

I venture to make the following remark:—

In the International Code for Meteorological Telegrams, settled by the Permanent Committee, the state of the weather is given by figures 0–9; among these figures 7 denotes, according to the printed reports, dust-haze (Höhenrauch), that is to say, a phenomenon which usually occurs but very rarely and in special localities. The mention of this phenomenon may be very interesting in the monthly tables, but has scarcely any value for the international telegraphic service. It seems to me that it would be better to employ the figure 7 to indicate phenomena such as Hail, Aurora Borealis, &c.

N.B.—As far as I am aware, the institutions of the North of Europe use the figure 7 to indicate a slight haze in the horizon (in Norwegian and Danish "Dis"). In the first place this use of it, differing from the International Code, is not legitimate; and again, I do not think it suitable, because it does not give an exact idea of the cloudiness of the sky.

N. HOFFMEYER.

To the Permanent Committee
of the Congress of Vienna.

(3.) COPENHAGEN, 13th April 1876.

I venture to submit to the Permanent Committee the idea of combining with the second International Congress an Exhibition embracing for each meteorological institution:—

1°. A complete collection of all publications, old as well as recent.

2°. A complete collection of meteorological instruments used at stations of the second and third order.

(To avoid difficulties of conveyance, the barometers need not be filled with mercury. Thermometers and rain-gauges should be perfectly mounted, as at the stations.)

3°. Specimens of special instruments, such as atmometers, actinometers, &c.

4°. Charts, on a large scale, representing the situation of the stations of different kinds, such as international, telegraphic, synchronous, climatological, rain stations, &c.

5°. Curves drawn on a uniform scale and representing the daily and annual range of the meteorological elements at the principal stations of the system.

6°. A detailed catalogue, containing the exact title of the publications, the description and price of the instruments, the geographical position and altitude of the stations, &c.

N. HOFFMEYER.

To the Permanent Committee
of the Vienna Congress.

METEOROLOGICAL SOCIETY.

30, Great George Street, Westminster, S.W.
17th April 1876.

DEAR SIR,

IN the Reports of the Vienna Congress and of the Permanent Committee certain thermometers and other instruments are mentioned which are quite unknown in this country. I should like therefore to suggest to the Permanent Committee the desirability of publishing a description of all the recognised meteorological instruments in each country.

Yours faithfully,
WILLIAM MARRIOTT.

R. H. Scott, Esq., F.R.S.

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LIST OF PUBLICATIONS, &c. issued under the Authority of the Meteorological Council.

OFFICIAL.

No.

1. Report for 1867. Presented to Parliament. 1s.
2. Instructions for Meteorological Telegraphy. New Edit. (1875). 6d.
3. Fishery Barometer Manual. 6d.
4. Charts of Surface Temperature, South Atlantic Ocean. 2s. 6d.
5. Report for 1868. Presented to Parliament. 5d.
6. Report for 1869. Presented to Parliament. 10d.
7. Quarterly Weather Report, 1869.—Parts I. to IV. 2s. each.
8. Barometer Manual. 1s. (New Edition, in the Press.)
9. Quarterly Weather Report, 1870.—Parts I. to IV. 5s. each.
10. Report for 1870. Presented to Parliament. 10d.
11. Contributions to our Knowledge of the Meteorology of Cape Horn and the West Coast of South America. 2s. 6d.
12. Currents and Surface Temperature of the North Atlantic Ocean, from the Equator to Lat. 70° N., for each month of the year, with a General Current Chart. 2s. 6d.
13. A Discussion of the Meteorology of the Part of the Atlantic lying North of 50° N. for the Eleven Days ending 8th February 1870. Price, with Book of Charts, 5s.
14. Quarterly Weather Report, 1871.—Parts I. to IV. 2s. each.
15. Report for 1871. Presented to Parliament. 10d.
16. Quarterly Weather Report, 1872.—Parts I. to IV. 3s. each.
17. Report for 1872. Presented to Parliament. 1s.
18. Contributions to our Knowledge of the Meteorology of the Antarctic Regions. 1s.
19. Quarterly Weather Report, 1870.—Parts I. to IV. 3s. each.
20. Charts of Meteorological Data for Square 5. Lat. 0–10° S., Long. 20–30° W., and Instructions to accompany the Weather Charts. Showing the Best Routes across the Equator for each Month. 20s.
21. Report of Proceedings of the Meteorological Congress at Vienna. 1s.
22. Report for 1873. Presented to Parliament. 4d.
23. Report of the Proceedings of the Conference on Maritime Meteorology held in London, 1874. 6s.
24. Instructions in the Use of Meteorological Instruments. 1s. 6d.
25. Quarterly Weather Report for 1874. Parts I. II. and IV. 3s. each. Part III. 5s. 6d.
26. Report for 1874. Presented to Parliament. 6d.
27. Charts of Meteorological Data for the Month of January and July, which lie between 90° N. and 10° S. and extend from 10° to 45° W., with accompanying Remarks. 24s.
28. Contributions to our Knowledge of the Meteorology of Japan.—By Rear-Admiral Thomas A. Brassey, C.B., Captain H.M.S. "Challenger." 1s.
29. Report for 1875. Presented to Parliament. 4d.
30. Quarterly Weather Report, 1875.—Parts I., II., III., and IV. 3s. each.
31. Report for Period of Seventeen Months ending 31st May 1876. Presented to Parliament. 2s. 6d.
32. A Discussion of the Meteorology of the North Atlantic during August 1879, with 31 Synoptic Charts. 10s.
33. Quarterly Weather Report for 1877. Part I. (In the Press.)
34. Contributions to our Knowledge of the Meteorology of the Pacific Region. Part I. 2s.
35. Report for 1877–8. 1s.

NON-OFFICIAL.

No.

1. Report to the Committee on the Connexion between Storm Winds and Barometrical Differences.—By R. H. Scott, Director of the Office. 6d.
2. Report to the Committee on the Meteorology of the South Atlantic.—By Captain H. Toynbee, Marine Superintendent. 1s.
3. Report to the Committee on the Use of Isobaric Curves.—By Captain H. Toynbee, Marine Superintendent. 1s.
4. Routes for Steamers from Aden to the Straits of Sunda and Leak. Translated from a Paper issued by the Royal Meteorological Institute of the Netherlands. 6d.
5. On the Winds &c. of the North Atlantic along the Tracks of Steamers from the Channel to New York. Translated from a Paper issued by the Deutsche Seewarte, Hamburg. 8d.
6. Report of the Proceedings of the Meteorological Conference at Leipzig. 1s.
7. Notes on the Form of Cyclones in Southern Indian Ocean.—By C. Meldrum, F.R.S., M.A. 2s. 6d.
8. Report on Weather Telegraphy and Storm Warnings. Presented to the Meteorological Congress, Vienna. 2s.
9. Report of the Permanent Committee of the Vienna Congress for 1874. 1s. 6d.
10. On the Physical Geography of the Sea of the Atlantic which lies between 20° N. and 10° S., and extends from 10° to 40° W. A Paper read before the British Association at Bristol, August 1875, by Captain Toynbee, Marine Superintendent. 1s. 6d.
11. Report of the Permanent Committee of the Vienna Congress for 1875. 2s.
12. Reports to the Permanent Committee of the Vienna Congress on Atmospheric Electricity, Maritime Meteorology, and Weather Telegraphy. 2s.
13. Reports of the Permanent Committee of the Vienna Congress. 1s.

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REPORT OF THE PROCEEDINGS

OF THE

SECOND INTERNATIONAL METEOROLOGICAL CONGRESS AT ROME.

1879.

Published by Authority of the Meteorological Council.

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GENTLEMEN,

I HAVE the honour, as authorised by you, to submit the English Translation of the Report of the Proceedings of the Second International Meteorological Congress held at Rome in the month of April.

Your obedient servant,

ROBERT H. SCOTT.

To the Chairman and Members of
the Meteorological Council.

October 15, 1879.

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REPORT OF THE PROCEEDINGS

OF THE

SECOND INTERNATIONAL METEOROLOGICAL CONGRESS AT ROME.

Protocol of the First Meeting, 14th April, 2h. p.m.

THE CONGRESS held its first meeting at the Ministry of Agriculture and Commerce, Rome, Monday, the 14th April 1879, at 2h. p.m.

Present: His Excellency the Premier, M. Agostino Depretis, the Delegates MM. Aguilar, Auwers, von Bezold, Blaserna, de Brito Capello, Bruhns, Cantoni, Denza, Hann, Hervé-Mangon, Hoffmeyer, Houzeau, Kokides, Lorenz, Mascart, Mohn, Müller, Neumayer, Palmieri, Paugger, Pittei, Plantamour, Pujazon, Rubenson, Salvatori, Schenzl, Scott, Smith, Snellen, Tacchini, Weyprecht, Wild.

MM. Hellmann, Mendeleef, Weihrauch, Zenger.

The members were received by M. Depretis, the Premier, who delivered an address, after which he declared the Congress open.

M. CANTONI, representing the President of the Permanent Committee, expressed the deep feeling of regret felt by the Congress at the circumstances which had prevented M. Buys Ballot from going to Rome.

He requested M. Mascart to read the address which M. Buys Ballot had prepared for the opening of the first meeting.

M. MASCART read M. Buys Ballot's address.

Mr. SCOTT, the Secretary of the Permanent Committee, read the list of the delegates sent to the Congress by the European Governments, and the Government of the United States. (See Appendix I., p. 31.)

The Acting President of the Permanent Committee, M. CANTONI, proposed to the Congress the provisional adoption of the Byelaws drawn up by the Permanent Committee. (Appendix II., p. 32.)

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These Byelaws were adopted, with a reservation suggested by M. PLANTAMOUR, that modifications of them might be proposed and discussed by the Congress.

The PRESIDENT also submitted, for the approval of the Congress, the programme proposed by the Permanent Committee. This programme was adopted. (Appendix III., p. 33.)

Upon the proposal of M. WILD, M. Cantoni was elected President of the Congress, by acclamation.

Upon the proposal of the PRESIDENT, the Congress completed the Bureau, in accordance with paragraph 2 of the Byelaws, by the election of two Vice-Presidents.

M. Wild, of St. Petersburg, and M. Plantamour, of Geneva, obtained the majority of votes.

The PRESIDENT proposed the nomination, by acclamation, of Mr. Scott of London, and Captain Hoffmeyer of Copenhagen, as Secretaries.

The PRESIDENT requested Mr. Scott, Secretary of the Permanent Committee, to read to the Congress the Report of the proceedings of that Committee. (Byelaws, paragraph 5; Programme, Article 2.)

Mr. SCOTT read the report (Appendix IV., p. 37), and laid upon the table a complete series of the printed documents issued by the Permanent Committee since the Congress of Vienna; viz.,—

1. Report of the Vienna Congress (1873) in English, French, and German.
2. Report of the Committee appointed by the Conference at Leipzig (1872) on Meteorological Telegraphy, in English and German.
3. Report of the Maritime Conference, &c. at London, 1874, in English.
4. Report of the Permanent Committee, 1874, in English, French, and German.
5. Report of the Permanent Committee, 1876, in English, French, and German.
6. Supplement to Report No. 5. Letter of M. de Brito-Capello, in English and German.
7. Report of the Permanent Committee, 1878, in English, French, and German.

He stated to the Congress that the majority of the manuscript documents which had been received from time to time by the Committee were sufficiently noticed in its three reports. As to more recent communications he laid them upon the table; viz.,—

1. Dr. Balfour Stewart; letter of 12th December 1878; on question 16 of the Programme.
2. Captain Hoffmeyer; letter of 14th December 1878. Question 23.
3. M. Sohncke; letter of 19th December 1878. Question 25.
4. M. Hildebrandsson; circular of 28th May 1878. Observations of "cirrus" clouds.

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5. Mr. Parkinson (sent by M. Wild); letter of 29th July 1878. Observations in the Pacific Ocean.
6. M. Wild; printed letter of 15th February 1879. Succinct Reports on some points of the Programme, &c.
7. M. Rikatcheff; printed communication (March 1879), *Vorschläge an den meteorologischen Congress.*
   A. On maritime meteorology.
   B. On meteorological telegrams.
8. Dr. Mühry; letter of 4th April 1879. On some points of the Programme.
9. Captain George Jinman (of London); letter of 12th April 1879. Respecting his theory of storms, with a copy of his work, "Winds and their Courses."
10. English Alpine Club; letters of 25th February and 3rd March 1879. On glacier observations.
11. The Austro-German Alpine Club; letter of 26th March 1879. On glacier observations.

Upon the proposal of M. HERVÉ-MANGON, the Congress passed a vote of thanks to the Permanent Committee for the zeal and devotion with which it had carried out the duties entrusted to it by the Congress of Vienna.

The Congress proceeded to the discussion of the Programme.

Upon the proposal of the PRESIDENT, questions 1, 2, 3, 7, 14, and 33 were reserved for examination at the general meetings of the Congress.

The PRESIDENT subdivided the other questions among five committees, viz.:—

I. Organisation; Nos. 8, 12, and 13.
II. Publications; Nos. 4, 5, 9, and 15.
III. Observations and Instruments; Nos. 10, and 16–25.
IV. Telegraphy. Maritime and Agricultural Meteorology; Nos. 6, 27, 28, 29, 34, and 35.
V. Elevated and distant stations; Nos. 11, 26, 30, 31, and 32.

M. PLANTAMOUR stated that he was charged by the Swiss Government to request that the subject of seismography might be added to the Programme.

M. CANTONI supported this proposal, which was accepted. This question was referred to Committee III.

M. BLASERNA proposed, and the Congress agreed, that M. de Rossi should be admitted to the Congress in order to be able to explain the construction of his seismographic instruments.

On the proposal of M. PITTEI, which was supported by M. VON BEZOLD, the question of the compilation of an International Dictionary of Meteorology was referred to Committee II.

M. WILD proposed to the Congress to include also in the Programme three proposals which are referred to in his "Succinct Reports."

The first was contained in a communication by Dr. Hellmann to the *Zeitschrift der oesterreichischen meteorologischen Gesellschaft*, March 1879, and "Succinct Reports," p. 2, c. 5.

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"Art. 9. I propose, therefore, that the Congress should express the wish that from these documents a universal catalogue of meteorological observations of all countries, viz., name of station, its geographical co-ordinates, list of the different elements observed, and of the years of observation, place of publication, should be prepared and published, and that it should place this task among the works to be executed in common, as indicated by Art. 12.

"I further propose that the Congress, in the same order of ideas, should also place among the latter class of inquiries the preparation and publication of a systematic catalogue of meteorological works of all countries,—including articles in scientific journals—and should invite the central institutions to contribute thereto by drawing up special catalogues for their respective countries according to a common plan."

The second was printed, Succinct Reports, p. 3, c. 11. "Art. 15. In order to facilitate the general adoption of the rules and formulæ for the reduction of barometric observations to the sea level, which we wish to be established, I propose to construct from these formulæ tables which will give easily for consecutive heights above the level of the sea both for the barometric reading and for the temperature observed at the time, the barometric reading corresponding to the level of the sea.

"Further it would be desirable that in accordance with the remarks and proposals recently formulated by Dr. Hellmann (Comparison of the Standard Barometers of St. Petersburg, Dorpat, Helsingfors, Stockholm, and Upsala, and General Remarks on the Reduction of the Barometer to 32° F., *Repertorium für Meteorologie, T. VI. No.* 8, November 1878), fresh tables for the reduction of the barometer to 32° F. should be calculated from the fresh and more precise data that we possess upon the expansion of mercury and brass, both for the metric and the English barometer, and also tables for the conversion of barometric observations expressed in millimetres into English inches and *vice versâ*. The general adoption of such tables would avoid the vexatious differences presented by the different tables hitherto used."

Both these propositions were referred to Committee II.

The third was printed, Succinct Reports, p. 4, Article 18. "I propose to include observations of the surface temperature of the soil among the elements to be observed at stations of the second order."

This proposal was referred to Committee III.

Capt. HOFFMEYER proposed the question of observations of upper clouds (cirrus) according to the plan of M. Hildebrandsson of Upsala; he expressed his satisfaction that the subject had been already mentioned in the Report of the Permanent Committee.

The question was adopted and referred to Committees II. and III.

On the proposal of Mr. SCOTT, the Congress unanimously adopted the following resolution:—

"The International Meteorological Congress of Rome, at its

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first meeting, has instructed its Secretaries to convey to the family of M. Dove the deep regret it feels at the death of that illustrious physicist, who has so greatly contributed to the progress of meteorology."

The Congress proceeded to the election of the Committees, who were constituted as follows:—

Committee I.

Organisation:—Questions 8, 12, and 13.

President - M. Wild.
Secretary - M. Bruhns.
Members - M. Auwers.
„ Hervé-Mangon.
„ Plantamour.
„ Rubenson.
„ Scott.
„ Smith.
„ Tacchini.

Committee II.

Publications:—Questions 4, 5, 9, and 15. Cirrus observations; Dictionary; Catalogue; Tables of Reduction.

President - M. Blaserna.
Secretary - M. Hann.
Members - M. Aguilar.
„ Bruhns.
„ Hellmann.
„ Pittei.
„ Scott.
„ Wild.

Committee III.

Observations and Instruments:—Questions 10, 16 to 25:- Seismography; Observations of the surface temperature of the soil.

President - M. Mascart.
Secretary M. von Bezold.
Members - M. Cantoni.
„ Capello.
„ Hozeau.
„ Mendeleeff.
„ Mohn.
„ Palmieri.
„ Scheuzl.
„ Snellen.
„ Wild.

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Committee IV.

Telegraphy, Maritime Meteorology, Agricultural Meteorology: —Questions, 6, 27, 28, 29, 34, and 35.

President	-	M. Neumayer.
Secretaries	-	MM. Müller and Brault.
Members	-	M. Bruhns.
		„ Capello.
		„ Denza.
		„ Hann.
		„ Hoffmeyer.
		„ Lorenz.
		„ Mascart.
		„ Myer.
		„ Pittei.
		„ Pujazon.
		„ Salvatori.
		„ Scott.
		„ Wild.

Committee V.

Elevated and distant stations:—Questions 11, 25, 30, 31, and 32.

Observations on the variations of glaciers.

President	-	M. Denza.
Secretary	-	M. Weyprecht.
Members	-	M. Hann.
		„ Hoffmeyer.
		„ Mendeleeff.
		„ Mohn.
		„ Neumayer.
		„ Plantamour.
		„ Scott.
		„ Wild.

The President proposed for the first meetings of the different Committees—

I.	Tuesday, 15th	-	-	-	9h. a.m.
II.	„ „	-	-	-	2h. p.m.
III.	„ „	-	-	-	11h. a.m.
IV.	„ „	-	-	-	4h. a.m.
V.	Wednesday, 16th		-	-	9h. a.m.

The President, in reply to M. Snellen, announced that the meetings of the Committees would be posted up in the Ministry.

The next general meeting was fixed for Thursday, 17th, at 9h. a.m.

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The PRESIDENT announced the order of the day.

Question 3.
Question 7.
Question 33.

The meeting rose at 5h. 30m.

Confirmed at the meeting of the 17th.,

G. CANTONI.

Protocol of the Second Meeting, 17th April 1879, at 9h. 30m. p.m.

Delegates present: MM. Aguilar, Auwers, von Bezold, Blaserna, Brault, de Brito Capello, Bruhns, Cantoni, Denza, Hann, Hervé-Mangon, Hoffmeyer, Houzeau, Kokides, Lorenz, Mascart, Mohn, Müller, Neumayer, Palmieri, Paugger, Pittei, Plantamour, Pujazon, Rubenson, Salvatori, Schenzl, Scott, Smith, Snellen, Tacchini, Weyprecht, Wild.

MM. Hellmann, Mendeleef, Weihrauch, Zenger.

The PRESIDENT requested the Secretary to read the protocol of the first meeting, which was adopted.

The PRESIDENT read to the Congress a telegram which he had just received from M. Majorana Calatabiano, Minister of Agriculture, Commerce, and Industry:—

"I beg that you will convey to the honourable members of the International Meteorological Congress the expression of my gratitude to them for their participation in the Congress of Rome, a participation which is equally honourable for themselves and for the science which they cultivate.

"I have much regretted not having been able to be present at the opening of the Congress, having been prevented by circumstances over which I had no control.

"I hope, however, to be able to be there before their departure, in order to have the pleasure of personally expressing to them my sentiments of gratitude."

Upon the proposal of M. PLANTAMOUR, the Congress requested the President to send to the Minister the following message:—

"MONSIEUR LE MINISTRE, &c.

"The Congress has received with most sincere gratitude the telegram by which you welcome it to Rome, and in which you express the interest that you take in its labours.

"The Congress requests me to express to you their acknowledgments, and the hope that they will see you at Rome before the end of the meetings.

"G. CANTONI,
"President of the Congress."

The Secretaries announced the receipt of the following documents:—

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A letter from M. Marié-Davy, of April 11, 1879. Referred to Committee III.

A letter from Baron Friesenhof, of November 4, 1878. Referred to Committee IV.

A letter from Mr. J. Allan Broun, of April 7, 1879. Referred to Committee V.

M. DE BRITO-CAPELLO presented to the Congress several copies of the publications of his observatory, viz. :—

A. Resumé of the different meteorological elements observed at the Observatory of the Infante D. Luiz during 20 *years* (1856–1875).

B. Temperature of the air at Lisbon, calculated in 5*-day means, during* 20 *years* (1856–1875). *Annual and diurnal variations, calculated by Bessel's formula.*

C. Atmospheric pressure at Lisbon for 5*-day means, during* 20 *years* (1856–1875). *Annual and diurnal variations, calculated by Bessel's formula.*

D. Rainfall at Lisbon during 40 *years. Observations by M. Franzini, from* 1836 *to* 1855, *and the continuation at the Observatory of the Infante D. Luiz, from* 1856 *to* 1875.

E. Atmospheric electricity during 1877 *and* 1878. *Annual and diurnal variations.*

F. Meteorological résumé for Portugal.

Upon the proposal of the PRESIDENT and other members, the Congress invited the following gentlemen to the meetings :—

The Prince of Teano, President of the Geographical Society.

M. Bodio, Director of the Statistical Department.

M. Cannizzaro, Professor of Chemistry, and President of the Italian Commission of Weights and Measures.

M. Cecchi, Professor and Director of the Ximenian Observatory at Florence.

M. C. Correnti, First President of the Geographical Society.

M. Giordano, Director of the Geological Committee.

M. Govi, Professor of Physics at the University of Naples, and member of the International Committee of Weights and Measures.

M. Grassi, Assistant at the Central Meteorological Office.

M. Miraglia, Director of the Department of Agriculture.

M. Pisati, Professor of Physics, and Member of the Italian Commission of Weights and Measures.

M. Respighi, Director of the Observatory of the Capitol.

M. Sella, President of the Academy "dei Lincei."

The discussion on Article 3 of the Programme was opened :—

"Report on the conformity with each other, and with the decisions of the Congress of Vienna, of instruments, methods of observation, and publication of observations in the different countries."

M. WILD proposed that the preparation of this Report should be referred to the future International Committee.

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The PRESIDENT seconded this proposal, observing that this Report, which was to have been drawn up Dr. Jelinek, had not been presented to the Congress owing to the lamented death of that distinguished meteorologist.

Mr. SCOTT drew the attention of the Congress to the fact that, with regard to the European systems, the Report presented to the British Parliament in 1877* contained much useful information on question 3.

Finally the Congress adopted the following resolution :—

"*The Congress decides that the English Report mentioned by Mr. Scott be translated into French and German, and published as Appendix V. to the Report of the present Congress. At the same time it requests the future Committee to make such a Report for the next Congress, respecting the conformity of methods, &c. with the decisions of the Congresses of Vienna and Rome.*"

The Congress proceeded to the discussion of question 7.

" The Committee is of opinion that it is impossible at present to compile general instructions adapted in their details to the special peculiarities of all countries and all climates. It proposes, therefore, that the Congress should confine itself, in the case of anyone demanding typical instructions, to designating those of the existing instructions which are most conformable to the decisions of the Congress."

M. WILD proposed, as a modification of the latter portion of question 7, that the directors of central institutes who might be present should be invited to inform the Congress whether their instructions were in conformity with the regulations of the Congress of Vienna.

This proposal was adopted by the Congress, and the PRESIDENT requested from the Directors of the Central Institutions who were present preliminary information as to the degree of conformity of their instructions with the said resolutions.

M. MASCART declared that, as regards France, he would endeavour to follow as closely as possible the rules laid down at Vienna.

M. Aguilar considered the alteration of old rules as to observations, &c. serious, but he was ready to follow, as far as possible, the regulations made at Vienna.

As to the other systems of Europe, the directors whose names are given in the following list, announced that their instructions were in general conformable to the regulations of Vienna :—

MM.	v. Bezold	for Bavaria.
	Houzeau	„ Belgium.
	Hoffmeyer	„ Denmark.
	Scott	„ England.
	Neumayer	„ Germany (Deutsche Seewarte).

* Report of the Treasury Committee appointed to inquire into the conditions and mode of administration of the Annual Grant in aid of Meteorological observations. London, 1877, Appendix VIII.

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MM.	Snellen	for Holland.
	Cantoni	„ Italy.
	Mohn	„ Norway.
	Capello	„ Portugal.
	Wild	„ Russia.
	Bruhns	„ Saxony.
	Rubenson	„ Sweden.
	Plantamour	„ Switzerland.

The Congress passed to the discussion of question 33.

"Should we not recommend the general adoption of a certain first meridian, for example, that of Greenwich, for synoptic charts?"

M. BRUHNS proposed that the Congress should recommend the adoption of the same first meridian for all meteorological charts. He was of opinion that the meridian of Paris or Greenwich should be chosen; he preferred the latter, because most meteorologists used it.

M. PUJAZON thought that the choice of a similar projection for synoptic charts was of more importance than the choice of a similar first meridian.

He thought that for Spain there would be an inconvenience in abandoning the meridian of San Fernando (Cadiz), as he was opinion that similar difficulties might exist in other countries, he proposed the adoption for synoptic charts of the meridian of the Island of Ferro, in conjunction with the first meridian adopted in each country.

Professor SMITH supported the opinion that the choice of a first meridian was not of great importance, and he thought that in this respect the choice might very well be left free to meteorologists.

M. SNELLEN quoted the opinion expressed by M. Buys Ballot in his "Suggestions," and in the "Sequel to the Suggestions," an opinion which he was glad to find in accord with that of M. Bruhns.

M. PLANTAMOUR did not think that it was very important to adopt the same first meridian for all countries.

Captain HOFFMEYER wished for uniformity, in order to facilitate the comparison of different charts with each other.

M. WILD supported the opinion of Captain Hoffmeyer.

M. MOHN thought that the meridian of Greenwich should be adopted, on account of maritime observations for which that meridian is used.

M. NEUMAYER thought that it would be necessary to choose either the meridian of Paris or Greenwich, but he gave the preference to the latter, in order to facilitate the reduction of maritime observations.

M. BRAULT did not see the importance of a first meridian for synoptic charts, but he thought that for charts relating to nautical meteorology that of Greenwich was preferable.

Mr. SCOTT supported the opinion of M. Neumayer. He thought that the meridian of Ferro should be abandoned; that meridian

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had been chosen because it made all longitudes for Europe east, but such a meridian did not suit transatlantic countries better than those of Greenwich or Paris.

The PRESIDENT put M. Pujazon's proposal to the vote, viz.:—

"The Congress, while recognising that the general adoption of a certain first meridian would present several advantages for synoptic charts, restricts itself to recommending the insertion of a second scale in which the longitudes are reckoned from the old first meridian of geographers, that of the Island of Ferro."

This proposal was not adopted.

M. MASCART thought that the adoption of the meridian of Paris was necessary for the climatology of France, and that in the proposal of M. Bruhns a distinction should be made between the different kinds of meteorological charts.

M. WILD supported the proposal of M. Bruhns. It was agreed that this proposal should be divided into two parts.

The PRESIDENT put the first part to the vote, viz.:—

"*The Congress recommends the adoption of the meridian of Greenwich as a starting point for the construction of synoptic meteorological charts.*"

This proposal was accepted by the majority.

The PRESIDENT then put the second part to the vote:—

"*In the event of another meridian being used in the construction of meteorological charts, the Congress recommends that an indication should be given upon the chart of the difference of longitude between the first meridian adopted and the meridian of Greenwich.*"

This proposal was unanimously adopted.

The next meeting was fixed for Saturday, 19th April, at 9h. a.m.

The PRESIDENT announced the order of the day.

The Report of Committee No. III. (Instruments and observations.)

The Report of Committee No. I. (Organisation.)

The meeting was adjourned at 11 o'clock.

Confirmed at the meeting of the 19th,

G. CANTONI.

Protocol of the 3rd Meeting, 19th April, at 9h. 45m. a.m.

Delegates present: MM. Aguilar, Auwers, von Bezold, Blaserna, Brault, Bruhns, Cantoni, Capello, Denza, Hann, Hervé-Mangon, Hoffmeyer, Houzeau, Kokides, Lorenz, Mascart, Mohn, Müller, Neumayer, Paugger, Pittei, Plantamour, Pujazon, Rubenson, Salvatori, Schenzl, Scott, Smith, Snellen, Tacchini, Weyprecht, and Wild.

MM. Hellmann, Mendeleef, Weihrauch, and Zenger.

Guests:—MM. Cecchi, de Rossi, Giordano, Govi, Grassi, Miraglia, Pisati, and Respighi.

The protocol of the second meeting was read and confirmed.

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The PRESIDENT read the following communication:—

"MONSIEUR LE PRÉSIDENT,

"TO-MORROW, Sunday, at 1h. p.m., there will be a meeting of the Royal Academy *dei Lincei* at the Capitol.

"Those of our colleagues of the Meteorological Congress who may wish to be present will be welcome.

"P. BLASERNA,
"Secretary of the Academy."

The PRESIDENT made the following announcement:—

"From information received at the Ministry of Foreign Affairs, General Myer has not been able to leave America before the 12th April, so that he will not be able to reach Rome before the close of the Congress."

The Secretaries announced the receipt of a letter from Mr. Buchan, dated 14th April 1879, with reference to question 17, *Exposure of Thermometers*, which had been already considered by Committee No. III.

The discussion on the Report of the Third Committee (Instruments and Observations), *Appendix VI.*, p. 69, was opened.

M. MASCART, President of the Committee, read to the Congress its resolutions on the different points which had been submitted to it.

Question 10. "The Committee proposes to have a comparison made of the standard barometers and thermometers of all the Meteorological Institutes, by referring them to a certain barometer and thermometer which, for the time being, appear to be the best verified. Inasmuch as the International Office of Weights and Measures of Paris will be in possession of such verified standard instruments, a comparison should be instituted with them, and they should serve as a basis for all corrections. At the same time any questions about accurate height above sea level of standard barometers should be raised."

Resolution: "*The Congress recommends the directors of all central institutions to have their instruments compared with the standard instruments of other countries.*"

This resolution was adopted.

Question 16: "The Committee proposes the establishment of uniform rules for determining the fixed points of thermometers."

Resolution: "*The Congress is of opinion that the method indicated in M. Pernet's report on the determination of the fixed points of thermometers should be provisionally accepted.*"

This resolution was adopted.

Question 17: "Can definitive rules now be established for the most suitable exposure of thermometers destined to give the temperature of the air?"

Resolution: "*The Congress without actually prescribing a fixed form of thermometer screen suitable for different climates and even for the exigencies of observers, draws the attention of meteorologists to the reports and communications presented to the Congress, either as printed papers, or in the protocols of the meetings of the Committee.*"

This resolution was adopted.

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Question 18: "Have additional comparative experiments been made since the First Congress for forming an opinion of the different methods for determining earth temperature which give more definite information as to their relative value?"

M. WILD's proposal for observations of the surface temperature of the soil.

Resolution: "*The Congress has not been informed of any new experiments made on this subject since the date of the Vienna Congress, and, in conformity with M. Wild's suggestion, proposes to include the temperature of the surface of the earth among the meteorological elements to be observed at stations of the second order.*"

This resolution was adopted.

Question 19: "Have decisive experiments been made since the First Congress to find a simple and appropriate method for determining radiation, and what is the relation between this and the amount of aqueous vapour in the atmosphere?"

Resolution: "*The Congress finds that the researches into the subject of radiation are not yet sufficiently advanced to enable it to propose a method of observation, and considers that the question should be referred to the next Congress.*"

This resolution was adopted.

Question 20: "What progress has been made in methods for determining the humidity of the air?"

Resolution: "*The Congress recommends the employment, as far as may be possible, of a regular arrangement for ventilation in the determination of the humidity of the air by means of the dry and wet bulb thermometers.*"

This resolution was adopted.

Question 21: "What progress has been made in the methods of determining evaporation?"

Resolution: "*The Congress points out that atmometers generally should fulfil certain conditions of comparability, and expresses the opinion that there is need of fresh researches being undertaken, for the determination of the form and exposure of the instruments to be employed.*"

This resolution was adopted.

Question 22: "Is there any reason to change, after further experience, the decisions of the First Congress respecting the instruments and methods for measuring the quantity of rain or snow?"

Resolution: "*The Congress thinks that, for stations of the second and third order, a diameter of eight or even of four inches is sufficient for the rain gauge.*"

"*As to the position of the rain gauges, the Congress confines itself to recommending that they should never be placed upon a roof, but that they should be sufficiently elevated to be out of the influence of drifting snow, and of the splashing of drops from the ground, while they must not be sheltered by trees or other neighbouring objects.*"

MR. SCOTT said he was pleased to learn that, in accordance with

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the opinions on rain gauges frequently expressed by Messrs. Buchan and Symons, the size of the gauge now proposed was much less than that proposed by the Congress of Vienna.

The resolution was adopted.

Question 23: "How may absolute values of the velocity of the wind be deduced from the direct indications of different anemometers?"

Resolution: "*The Congress does not feel itself prepared at present to reply to the question of the determination of wind velocity. It confines itself to recommending the directors of central institutions to effect a comparison between the anemometers employed in different countries.*"

Captain HOFFMEYER requested that the question might be left to the future International Committee.

Mr. SCOTT called the attention of the Congress to the action taken at Vienna respecting anemometers, where M. Wild's instrument had been recommended for general introduction at stations of the Second Order, while the Committee of the present Congress had not adopted any special resolution upon the subject.

He pointed out to the members of the Congress the importance of preserving as much as possible the continuity of the proceedings of the two Congresses.

M. TACCHINI supported the proposition of Captain Hoffmeyer that the International Committee should be charged with the examination of the question.

M. WILD said that the Committee had made a point of not recommending any special instrument, since the adoption of such a recommendation would imply a judgment on the part of the Congress which might perhaps be inconvenient. For this reason he had recalled the proposal which he had made of indicating the instruments which should serve as starting points for the comparison of the standard barometers and thermometers of the different countries; and he requested the Congress not to have regard to the previous decision of the Congress of Vienna in considering the question which was now before it.

The PRESIDENT remarked that the question resolved itself into two parts:—

1°. Whether the comparison should be made in each country only.

2°. Whether, in addition, there should be an international comparison.

Captain HOFFMEYER renewed his proposal that the Committee should be charged with such a comparison.

Professor SMITH supported the views of MM. HOFFMEYER and TACCHINI, and proposed to add the following resolution:

"*If the future International Committee finds that the question is sufficiently advanced, it will propose an international comparison of anemometers.*"

The PRESIDENT put the proposal of the Committee to the vote, and it was adopted; and afterwards the proposal of Professor SMITH, which was also adopted.

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Question 24: "Have since the last Congress better methods been discovered for measuring the ozone in the atmosphere?"

Resolution: "*The Congress thinks that the difficult question of the determination of ozone does not, in its present condition, permit of a definite solution.*"

This resolution was adopted.

Question 25: "What progress have the methods for determining atmospheric electricity made, and what results have observations of this kind furnished hitherto?"

Resolution: "*The Congress is of opinion that the study of atmospheric electricity has made marked progress in recent years, and recommends that a comparison should be made between the instruments which are most generally used.*"

Lastly, on the question of seismometry, which had been referred to Committee No. III. by the Congress at its first meeting, the Congress adopted the following resolution:—

"*After having heard with interest the report on the investigations of M. de Rossi on the phenomena which he comprises under the term 'Endogenous Meteorology,' the Congress expresses its desire to see such researches continued, and insists upon the relations which may exist between them and those of general meteorology.*"

The Congress proceeded to the Report of Committee No. I. (Organisation).

M. BRUHNS, Secretary of this Committee, read the Report (Appendix VII., p. 73).

Three questions were referred to the Committee, viz.:—

"8. The Committee proposes to establish, by small annual contributions from all countries taking part in the Congress, an international fund, for the expenses incurred by such joint undertakings as those named in the following sections, and the expenses of postage and printing for the Congress and its Permanent Committee."

"12. The Committee is of opinion that the establishment of an International Meteorological Institute is at present not possible, nor even desirable, and propose to provide for the functions and labours which might devolve upon such an institution in the following manner:—

"(*a.*) The international administrative functions, such as the execution of the decisions of the Congress, the convening of future Congresses, the care of joint international investigations and undertakings, the administration of the international fund, &c. will be confided, as is already partly the case, to a *Permanent Committee* elected from time to time by a Congress, and required to give an account of its action to the next Congress.

"(*b.*) As regards researches which embrace a considerable portion of the globe for the purpose of deducing general laws in meteorology, it is desirable that permanent relations for the communication of materials should be established between the different central institutes, and that the publications appearing in each country should

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be distributed gratuitously to all institutes and to all persons who take part in the investigations. These publications are to be, moreover, rendered generally accessible through the agency of booksellers. These international investigations will be based upon the publication of the observations of each country according to the international form, and besides on the special labours which each country may be willing to undertake with regard to its own climate. In the case of supplementary information being required for any countries, it is desirable that a suitable system of reciprocal communications should be devised."

"13. The Committee considers the following subjects as possessing a general interest:—

"(*a.*) The critical collection and discussion of all existing data on the diurnal and annual range of Air Temperature, and attempts to deduce general laws therefrom.

"(*b.*) The critical collection and discussion of all existing data on the diurnal and annual range of Absolute and Relative Atmospheric Humidity, and attempts to deduce general laws therefrom.

"(*c.*) The critical collection and discussion of all data on the diurnal and annual range of the Amount of Cloud.

"(*d.*) Wind tables for the 12 months and for the year.

"(*e.*) Tables of precipitation for the 12 months and for the year.

"(*f.*) New tables of atmospheric pressure, with isobars, for the 12 months and for the year.

"(*g.*) Charts of the movements of storms.

"(*h.*) Daily synoptic charts, embracing considerable portions of the globe."

The Committee proposed the following resolutions:—

"A.—I. *The second Meteorological Congress, assembled at Rome, institutes an* International Meteorological Committee, *which is charged with everything that concerns international relations until the meeting of the next Congress.*

"2. *The Committee is composed of nine members, elected by ballot, under the restriction that two delegates of the same country cannot hold seats on it at the same time.*

"3. *In case of vacancy by the resignation or by the death of one of its members, the Committee may complete itself by the co-option of a new member, having regard to the restriction above indicated.*

"4. *The Committee elects its own executive officers and distributes its labours among the different members.*

"5. *The Committee is charged with seeing that the decisions of the Congress are carried out; with the convening of future Congresses; with the preparation of the questions which should be submitted to this Congress; with the keeping the delegates to the present Congress informed of its proceedings and of its decisions;*

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and lastly, with the presentation to the next Congress, at the expiration of its functions, of a report embracing the whole of the period.

" B. *The Congress is of opinion that a new Congress should be convened after a maximum interval of five years.*

" C. *As regards researches which embrace a considerable portion of the globe for the purpose of deducing general laws in meteorology, it is desirable that permanent relations for the communication of materials should be established between the different central institutes, and that the publications appearing in each country should be distributed gratuitously to all institutes and to all persons who take part in the investigations. These publications are to be moreover rendered generally accessible through the agency of booksellers.*

" *The Congress considers the following subjects, among others, as researches having a character of general interest:*

" (a.) *The critical collection and discussion of all existing data on the diurnal and annual range of air temperature, and attempts to deduce general laws therefrom.*

" (b.) *The critical collection and discussion to all existing data on the diurnal and annual range of absolute and relative atmospheric humidity, and attempts to deduce general laws therefrom.*

" (c.) *The critical collection and discussion af all data on the diurnal and annual range of the state of the sky, that is, of the amount of cloud.*

" (d.) *Wind tables for the* 12 *months and for the year.*

" (e.) *Tables of precipitation for the* 12 *months and for the year.*

" (f.) *New tables of atmospheric pressure, with isobars, for the* 12 *months and for the year.*

" (g.) *Charts of the movements of storms.*

" (h.) *Daily synoptic charts, embracing considerable portions of the globe.*

" *The directors of the central institutions are invited to have these works executed as soon as possible for the stations of their respective countries, and published, in order that they may serve as a basis for researches which may be undertaken on the general march of meteorological phenomena over the surface of the globe.*

" *Before undertaking the investigation of any one of the above-mentioned subjects, the public establishments are invited to acquaint the President of the International Committee of their intention, and he will inform the directors of all the central institutions.*

" D. *The Congress resolves not to carry out the eighth proposal of the Programme, relative to the formation of a small international fund by means of small annual contributions by all the countries taking part in the Congress.*"

M. SNELLEN requested the postponement of the consideration of this Report.

This proposal was not accepted.

M. SNELLEN then proposed the following resolutions:—

1°. " The Congress shall institute an International Office of Meteorology.

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2°. "This Office shall consist of a President, assisted by as many salaried *employés* as shall be necessary.

3°. "The Office shall have no initiative nor any legislative power; it shall be charged only with the carrying out of the decisions of the Congress and the preparation of a future Congress. For this purpose it should be in correspondence with the different meteorologists in order that it may know what are their wishes."

M. PLANTAMOUR proposed that a limited Sub-Committee should be nominated, forming part of the General Committee.

M. SNELLEN remarked that a large Committee would find great difficulties in the way of correspondence.

The PRESIDENT put M. Snellen's proposal to the vote, which was not accepted.

The resolution A. 1 of the Committee was adopted.

The Congress proceeded to the consideration of No. A. 2.

Captain HOFFMEYER inquired the reason for selecting only nine members.

M. WILD explained that the Committee had wished to include the directors of the central institutions of all the great countries.

Captain HOFFMEYER made the following proposal:—

"The International Committee of Meteorology shall be composed of all the directors of the independent meteorological systeme of the different countries."

Mr. SCOTT remarked that it was impossible to define with precision the expression "independent systems," and reminded the Congress that there were several independent meteorological systems in the British Isles.

M. PLANTAMOUR did not oppose the increase of the number of the members of the Committee, but he also considered the expression of "independent systems" too vague and ambiguous.

M. VON BEZOLD thought that a numerous Committee would work slowly.

Captain HOFFMEYER was of a different opinion, as all the directors would be members of the Committee.

M. SNELLEN proposed that the Committee should be composed of three members only.

This proposal was not accepted.

The proposal A. 2 of the Committee was adopted.

Proposals A. 3–5, B., C., and D. of the Committee were put to the vote successively by the President and adopted.

The next meeting was fixed for Monday the 21st, at 10h. a.m.

The PRESIDENT announced the Order of the Day:—

1. Election of the members of the International Meteorological Committee.
2. Report of Committee No. II. (Publications.)

The Meeting was adjourned at noon.

Confirmed at the meeting of the 21st.

G. CANTONI.

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Protocol of the Fourth Meeting, 21st April 1879, at 10h. 15m. a.m.

Delegates present: MM. Aguilar, Auwers, von Bezold, Blaserna, de Brito Capello, Bruhns, Cantoni, Denza, Hann, Hoffmeyer, Houzeau, Kokides, Lorenz, Mascart, Mohn, N umayer, Pittei, Plantamour, Pujazon, Rubenson, Salvatori, Scott, Smith, Snellen, Tacchini, Weyprecht, and Wild.

MM. Hellmann, Mendeleef, Weihrauch, Zenger.

Visitors: MM. Cecchi, de Rossi, Grassi, Pisati, Respighi.

Commander Majorana-Calatabiano, Minister of Agriculture and Commerce, entered the hall of the Congress. The President introduced to him all the members who were present. The Minister expressed his lively satisfaction at his having been able to make the personal acquaintance of the distinguished foreign delegates who had honoured the Congress at Rome with their presence. He added that he knew that their counsels and their labours would be very beneficial to the progress of meteorology, and especially to the important applications to which that science may give rise.

The PRESIDENT replied that he conveyed the deep sentiments of gratitude of all the foreign delegates for the general hospitality which they had received at Rome from the Government and from the country.

The protocol of the third meeting was read and confirmed.

The PRESIDENT, in the name of M. Bodio, Director-General of Statistics, presented to the Congress a copy of a work which had just appeared and of which he intended to send copies to all the members of the Congress:—*Monografia della Città di Roma e della Campagna romana, presentata all' Esposizione universale di Parisi nel* 1878. *Parte prima e seconda con atlante. Roma, tipografia Elzeviriana.*

M. PLANTAMOUR expressed the thanks of the Congress for this liberality.

Mr. SCOTT announced the receipt of a work entitled:—*Indice metodico della monografia degli strumenti meteorologici, compilata dal dottore Isidoro Pistolesi, colla tavola degli autori e l'alfabets degli strumenti. Pisa, presso Rocco Vannucchi,* 1845.

In the absence of the author, M. MASCART laid upon the table a printed list entitled:—*Travaux de Météorologie nautique entrepris au Dépôt des Cartes et Plans de la Marine française sous la direction de L. Brault, lieutenant de vaisseau, chef du service météorologique.*

The Congress proceeded to the election of the members of the International Meteorological Committee.

M. BRUHNS proposed that the voting should not be by countries, but that the names of the delegates present should be called. He further proposed that it be permitted to add the names of absent meteorologists, for instance, of M. Buys Ballot; for himself, however, he absolutely declined to be nominated.

M. WILD asked whether all meteorologists could be elected; even those who are not delegated by their governments to attend the Congress.

M. BRUHNS was of opinion that only those delegates who had been prevented from attending were eligible.

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M. SNELLEN announced that M. Buys Ballot would not accept a nomination to the Committee, from considerations of principle.

M. MASCART thought that the Congress should not take such a reservation into account, and hoped that in the interest of the science, M. Buys Ballot would accept the functions which the Congress would not fail to entrust to him.

The PRESIDENT requested MM. Mohn and Snellen to act as scrutineers.

The scrutineers having collected the votes, declared that according to the voting of the Congress the Committee was composed of the following members:—

MM. Buys Ballot, Cantoni, de Brito Capello, Hann, Mascart, Mohn, Neumayer, Scott, Wild.

The Congress passed to the discussion of the report of Committee No. II. (Publications.)

M. BLASERNA, President of the Committee, read the report (Appendix VIII., p. 74), upon questions 4, 5, 9, and 15, and also upon observations of upper clouds and the compilation of an international dictionary of meteorology.

Question 4: "Report of M. Buys Ballot on the methods employed in the different countries for obtaining true daily means from the various combinations of hours of observation.

Resolution: "*The Congress proposes that each country be invited to establish at a certain number of points, regard being paid to local conditions, stations at which continuous observations should be made by means of self-recording instruments, or else hourly observations during several term-days in each month, or lastly continued, equidistant, and frequent observations (eight times a day at least), in order to obtain the necessary data for reducing to true means the means of observations made twice or thrice a day at ordinary stations.*"

This resolution was adopted.

Question 5: "The Committee proposes the general adoption of the forms of publication already introduced in several countries for observations at a certain number of stations of the second order, chosen in each country as international stations. (See the reports of the Committee for the years 1873 and 1874, 3rd meeting at Utrecht, and Appendix F.)"

Resolution: "*The Congress adopts for the observations of a certain number of stations of the second order, chosen as international stations, the form of publication proposed in* 1874 *by the Permanent Committee of the Vienna Congress and printed in its report for that year.*"

This resolution was adopted.

Upon the question as to the information published with regard to Wind, M. Weihrauch has made a communication on the subject, in relation to which the Committee proposed the following resolution:—

"*The monthly and yearly resumés published by the central offices for the different stations contain, in accordance with the resolutions of the Congress of Vienna, a summary of the frequency of the eight principal directions of the wind, both for the months and for the*

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year. Seeing the importance which must be attached not only to the direction but also to the force of the wind, the Congress proposes to publish also in these summaries the mean force of each wind, and for the greatest possible number of stations for each month and for the year. Where the form adopted allows sufficient space, the figures representing the frequency and the mean force should be placed side by side, otherwise it is preferable to give both in the form of an appendix."

M. RUBENSON remarked that sufficient space could not be found in the international form.

M. BLASERNA explained that there was perhaps space in the form adopted for the Italian stations; if the directors of other institutions could not find space, the indications of wind force might be given in an appendix.

The resolution was adopted.

Question 9: "The Committee requests the delegates to prepare for the Congress at Rome a catalogue of the meteorological observations, both published and unpublished, in their respective countries."

M. HELLMANN proposed to add thereto the publication of a catalogue of works and memoirs respecting meteorology.

Resolution: "*The Congress states with pleasure that very valuable preliminary work corresponding to article No. 9 of the Programme and to M. Hellmann's proposal has been already partly executed. But as it is to be desired that these materials should be collected in a general catalogue, the Congress proposes that these publications be divided into two categories:—*

"*1°. A catalogue of series of observations.*

"*2°. A catalogue of meteorological works and memoirs.*

"*As to the first category, the Directors of the different Meteorological systems are invited to prepare catalogues of the published and unpublished observations in their respective countries, and to inform the International Committee of the work already done in that direction.*

"*As to the second category, the Congress is of opinion that the works already done by Professor Cleveland Abbé, and the catalogues already printed of the library of the Meteorological Society of London and of that of the Observatory of Brussels, might well serve as a starting point for more comprehensive publications, and invites all the directors of other meteorological libraries to add the list of works and memoirs which are not yet entered in these catalogues.*"

M. HOUZEAU placed upon the table a copy of the *Catalogue des ouvrages d'astronomie et de météorologie qui se trouvent dans les principales bibliothèques de la Belgique, préparé et mis en ordre à l'observatoire royal de Bruxelles; suivi d'un appendice qui comprend, tous les autres ouvrages de la bibliothèque de cet établissement* (Bruxelles, F. Hayez, Printer of the Royal Academy, 1878).

M. WILD announced that for Russia there already existed a catalogue for published observations, viz., *Catalogue des Observations météorologiques en Russie dressées par F. Claver*, and published in 1872 in the *Repertorium für Meteorologie*, T. II. The Central Physical Observatory of Russia intended to publish shortly a supplement to this catalogue.

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As to the unpublished observations which exist in the archives of the Central Physical Observatory, it was also intended to publish a catalogue shortly.

M. NEUMAYER announced that the German Government had purchased for the Deutsche Seewarte the library of the late Professor Dove, of Berlin. A complete catalogue of this library was now being prepared, and would be presented to the International Committee.

The resolution was adopted.

As to the question of an international dictionary, proposed by M. PITTEI, the following resolution was adopted:—

"The Congress is of opinion that it would be very useful that an international dictionary of meteorology should be published."

Question 15: "The Committee recommends the establishment of rules and formulæ for reducing barometric readings to the sea level in a uniform manner."

The Congress, in accordance with the Reports of MM. Bruhns and Hellmann, finally adopted the following resolutions:—

1°. *"The reduction to the sea level by the addition of a constant quantity during the whole year is only admissible for heights not exceeding* 20 *metres, if we wish to obtain an accuracy of* $\pm$ 0·5 *mm.* ($\pm$ 0·002 *in.*)

"Consequently for stations situated at a height exceeding metres, account must be taken of the temperature and approximately of the relative humidity, according to Laplace's method.

2°. *"In weather reports it is desirable that the barometric readings unreduced should be given by the side of the readings reduced to the sea level; in other publications it is necessary to have in all cases unreduced readings.*

3°. *"It is desirable that the International Meteorological Committee should undertake the compilation of fresh uniform tables for the reduction of barometric readings to the level of the sea.*

4°. *"It is equally desirable that the Committee should undertake the preparation of a collection of tables which may be employed in the meteorological systems of the different countries."*

The four resolutions were submitted to the Congress *en bloc* and adopted.

On the question of observations of "cirrus" clouds proposed by M. HILDEBRANDSSON, the Congress adopted the following resolution:—

"The observation of the direction of the upper clouds, and especially of cirrus, at some stations in each country, and the publication of these observations in the form of an appendix, is strongly recommended."

The next meeting was fixed for Tuesday, 22nd, at 1h. 30m. p.m.

The PRESIDENT announced the Order of the Day:—

1°. Report of Committee IV.

2°. „ „ V.

The meeting closed at noon.

Confirmed at the meeting of the 22nd, G. CANTONI.

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Protocol of the Fifth Meeting, 22nd April, at 2h. 10m. p.m.

Delegates present: MM. Aguilar, Auwers, von Bezold, Blaserna, Bruhns, Cantoni, Capello, Denza, Hann, Hoffmeyer, Houzeau, Kokides, Lorenz, Mascart, Mohn, Müller, Neumayer, Paugger, Pittei, Plantamour, Pujazon, Rubenson, Salvatori, Schenzl, Scott, Smith, Snellen, Tacchini, Weyprecht, Wild.

MM. Hellmann, Mendeleef, Weihrauch, Zenger.

Visitors: MM. Cecchi, de Rossi, Grassi, Miraglia, Pisati, Respighi, Sella.

The protocol of the fourth meeting was read and confirmed.

Mr. SCOTT announced the receipt of a letter from M. Bucchich, dated March 12, 1879, respecting question 35, Agricultural Meteorology. This letter had already been considered by Committee No. IV.

The PRESIDENT announced the receipt of the following works:—

Sismografo elletrico a carte affumicate scorrevoli, nota del P. F. Cecchi. Roma, 1876, *con tavola annessa.*

Sismografo elettrico a carte affumicate scorrevoli del P. F. Cecchi direttore dell' Asservatoris Ximeniano, Firenze, 1877.

Sismographi a carte affumicate fisse del P. F. Cecchi. Firenze, 1877.

Il Termometro e il Barometro della Loggia dell' Orgagna in Firenze, del P. F. Cecchi. Firenze, 1871.

Tavola-Meteorografo Cecchi.

Il Microfono nella meteorologia endogena. Studi ed esperienze del professore Michele Stefano De Rossi. Roma, 1878.

The discussion upon the report of Committee No. IV. was opened (Telegraphy, Maritime Meteorology, and Agricultural Meteorology), Appendix IX., p. 75.

M. MÜLLER, secretary of the Committee, read the resolutions upon the different points that they had had to examine.

Question 6: "The Committee recommends the general adoption of the code of figures for Meteorological Telegrams proposed at its fourth meeting at Utrecht.

Question 27: "What progress has meteorological telegraphy made since the First Congress, and how can we contribute to its development?"

Resolution: "*The Congress recommends for meteorological telegrams the general adoption of the code of figures proposed by Permanent Committee at Utrecht, and states that the report which has been presented to the Congress on the actual condition of meteorological telegraphy contains some information with reference to Question* 27."

This resolution was adopted.

Question 28: "What progress has maritime meteorology made since the First Congress?"

Resolution: "*The Congress expresses the opinion that the Maritime Conference in London, in* 1874, *has fulfilled the conditions prescribed by the Congress of Vienna for the study of*

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maritime meteorology; it is of opinion, also, that in order to ensure the future progress of this branch of meteorology, the most perfect liberty should be accorded to the institutions interested in making mutually the arrangements which are most suitable for the execution of their investigations."

This resolution was adopted.

Question 29: "What results have the simultaneous observations given, and how may we contribute to their further development?"

M. NEUMAYER stated that the discussion of this question has been twice adjourned, in the hope that General Myer might be able to be present.

Resolution: "*The Congress is of opinion that the development of simultaneous observations contributes greatly to the progress of meteorology, and that all work done in this direction should be encouraged.*"

This resolution was adopted.

Question 34: "In what manner can we best organise and develope the construction and publication of synoptic charts, embracing considerable portions of the surface of the globe?"

A proposition made by MM. HOFFMEYER and NEUMAYER for combined work on a uniform plan on the preparation of Hoffmeyer's Synoptic Charts and the Monthly Review of the Deutsche Seewarte at Hamburg having been submitted to the Committee, and discussed by it, the following resolution was proposed:

Resolution: "*The Congress fully appreciates the importance of the publication which the Meteorological Institutes of Copenhagen and Hamburg propose to undertake, and it hopes for the realization of this project.*"

This resolution was adopted.

Question 35: "How can the development of meteorology in connexion with agriculture and forestry be forwarded by the Congress?"

Resolution: "*In order to contribute to the progress of agricultural and forest meteorology the Congress recommends as a programme for study:*

"1°. *The influence of the meteorological elements upon vegetation.*

"2°. *The inverse influence of vegetation upon the meteorological elements.*

"3°. *Agricultural warnings.*

"*The Congress, finding the subject too important to take a detailed resolution at this meeting, proposes to charge the International Committee with the convening of a special International Conference before next spring, to take into consideration the development of agricultural and forest meteorology.*"

M. BRUHNS wished that, before the meeting of the projected Conference, questions upon the organisation of the agricultural meteorological service in different countries should be addressed by the International Committee to the institutes charged with this service, in order to prepare a report for the Conference.

M. VON BEZOLD was of opinion that a too frequent recurrence of International Conferences would have a tendency to weaken the

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authority of Congresses. He would prefer to reserve such questions as that now under consideration for a Congress; nevertheless, he thought that this Congress should not be convened at a date earlier than that indicated by other considerations.

Mr. SCOTT remarked that the Maritime Conference of London, in 1874, was private, and that it had had considerable success.

The resolution was adopted.

The meeting was adjourned for an hour.

Upon resumption the discussion was opened upon the Report of Committee V. (Distant Stations, &c., Appendix X., p. 79.)

M. DENZA, President of the Committee, read the resolutions upon the different questions which it had had to examine.

Question 11 : "The Committee draws attention to the importance of establishing distant stations, and supplying them with the necessary instruments."

Question 32 : "In what manner should we proceed to establish meteorological stations in distant countries where observations have not hitherto been made?"

Resolution A. : "*The Congress expresses the opinion that the cost of establishment and maintenance of distant stations should not be borne by means of an international fund, but at the expense and under the care of the countries which are in relation with those localities.*"

This resolution was adopted.

Resolution B. : "*The Congress cannot give effect to the proposal of Mr. Parkinson, who has asked for funds for organizing a meteorological service in the Samoa Islands, because it has no international fund at its disposal; but with regard to the importance of this proposal, it expresses the hope that private initiative will permit of meteorological observations being taken in the Samoa Islands.*"

This resolution was adopted.

Resolution C. "*The Congress considering :*

"1°. *That it is of the highest importance that the meteorological stations established by different countries in parts of the globe which are very remote and difficult of access may be visited from time to time in order to ascertain the accuracy of the instruments and of the amount of confidence which can be placed in the observations.*

"2°. *That such an inspection may be most conveniently made by officers of the navies of the maritime Powers.*

"*Proposes to forward to the Governments of the countries represented at the Congress the request that they will kindly take the necessary steps, that, on the one hand, the officers commanding vessels visiting those parts may receive instructions, in pursuance of which they would place themselves in communication with the observers at those meteorological stations, whatever be the nationality of the latter, for the purpose of comparing the instruments, and of acquainting themselves with the manner in which the observations are made; and, on the other hand, that the observer charged with the care of the station may place himself at the disposal of the officer*

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visiting it, whatever be the maritime Power by which he is commissioned."

This resolution was adopted.

Resolution D.: "*The Congress recognizes that the establishment of meteorological stations in Bulgaria, Roumania, and Servia would be of the highest importance, and it begs the Italian Government to cause this wish to be communicated to the Governments of those States.*"

This resolution was adopted.

Question 26: "Have since the last Congress, hourly meteorological observations been made at new, and especially continental, stations within the tropics?"

Resolution A.: "*The Congress expresses the desire that the hourly observations made at the existing tropical stations may be continued, and that other analogous observatories may be established, especially in the interior of the continents of the Torrid Zone.*"

This resolution was adopted.

Resolution B.: "*The Congress, recognizing the great importance that meteorological stations in Brazil would possess for the progress of science, begs the Italian Government to make this desire known to the Government of that country.*"

This resolution was adopted.

Resolution C.: "*The Congress decides upon conveying to the Royal Society of London their expression of the importance it attaches to the continuation of the publication of the observations made at Trevandrum by M. J. Allan Broun, and upon requesting that Society to be good enough to take steps to this effect.*"

This resolution was adopted.

Question 30: "What observations do we possess from high mountains, and from balloon ascents, and what measures should be taken to organize these observations more completely?"

Resolution A.: "*The Congress, recognizing the importance that observations made in balloons, especially at places situated in the interior of the continents, may have for the physical study of the higher regions of the atmosphere, recommends the taking of observations of temperature and humidity by means of captive balloons and according to Glaisher's method, in strata at different heights, and on different days and in different seasons. It recommends also the study, by means of captive balloons, of the diurnal range of temperature and humidity in the upper strata of the atmosphere, and the detailed publication of these observations.*"

This resolution was adopted.

Resolution B. (a.): "*The Congress thinks that it would be very useful if observatories could possibly be established on the summits of mountains, and the observations published in extenso, so that they may be placed at the disposal of all meteorologists, and may aid in the solution of problems which may present themselves in future.*

(b.): "*The Congress insists upon the utility of a series of hourly observations of temperature, pressure, direction and force of wind, and eventually also of humidity, on Mount Washington, and especially at Pike's Peak, the highest station upon the earth. This*

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series should embrace one year at least; and it would also be desirable to publish in detail the observations already existing for these two stations. General Myer is requested to be good enough to realize these desires of all meteorologists.

(c.) : " *The Congress recommends the Swiss Society of Natural Sciences to do its utmost to promote the establishment of an observatory upon one of the high summits of Switzerland. It expresses the desire that meteorological stations may be established under similar conditions in Italy and other countries.*

(d.) : " *The Congress considers the establishment of the observatory of Etna, proposed by M. Tacchini, of that of Mont Cimone, proposed by M. Parenti, and that of Mont Ventoux, supported by the Meteorological Commission of the Department of Vaucluse, as enterprises of high scientific importance.*"

MM. Tacchini, Mascart, and Denza requested that this resolution might be brought to the knowledge of the different commissions who are charged with the arrangements relating to the establishment of these observatories.

This resolution was adopted.

Resolution C.: " *The Congress requests the directors of the meteorological systems of the various countries to be good enough to publish in a complete manner the existing series of observations made at elevated stations, and which have either not yet been published, or only in an incomplete manner; and at the same time to indicate and describe the stations of their systems which might furnish materials for the study of the upper regions of the atmosphere.*"

This resolution was adopted.

On the proposal of M. HANN, the Congress adopted the following resolution :—

" *The Congress draws the attention of meteorologists to the importance of measuring the variations in length and thickness of the glaciers in the different countries, in order to be able to deduce the relations which exist between these variations and those of the meteorological elements.*

" *As a means of extending our knowledge upon this question the Congress recommends :—*

(a.) : " *To form a complete critical collection of observations made in times past upon the variations of volume of the glaciers.*

(b.) : " *To institute in future continued observations at localities suitably chosen, upon the annual variations of the glaciers in length and thickness, and to publish the results.*

" *The Congress hopes to be able to rely upon the co-operation of the Alpine Clubs and other analogous societies in carrying out these researches.*"

Question 31 : " The Committee, after having taken cognizance of the scheme of M. Weyprecht to establish several observatories in the Arctic and Antarctic regions, so as to organize hourly meteorological and magnetical observations to be made simultaneously all around the Pole, is of opinion that these observations will be of the highest importance in developing meteorology and in extending our knowledge of terrestrial magnetism; it thinks,

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therefore, that in the interest of science, it should recommend general participation in this enterprise In what manner can the Congress on its part contribute to the success of the enterprise ?"

Resolution : "*The Congress recognises the great importance which should be attributed to synchronous meteorological and magnetical observations made in the polar regions, by means of simultaneous expeditions, and it recommends all Governments to give the most effective support to such undertakings.*

"*Considering :*

"1°. *That the majority of the members of the Congress are not provided with instructions relating to this question ;*

"2°. *That such instructions are absolutely necessary in order to arrive at definite resolutions ;*

"*The Congress decides to intrust the International Committee with the convening of a special Conference which should be composed of delegates provided with the necessary instructions and powers by their Governments, who may think they could participate in some way in the enterprise. By reason of the preparations already made by M. Weyprecht and Count Wilczek for an expedition of this nature, it thinks it necessary that this Conference should meet at Hamburg, on the 1st October 1879, in order to settle the details of the scheme and the means of carrying it out.*"

M. MASCART thought that the date (before Christmas 1879) proposed for the Conference was rather too early.

M. WEYPRECHT replied that unfortunately he and Count Wilczek could not agree to a later date, if the Congress could not give them the hope of co-operation.

The resolution was adopted.

Mr. SCOTT announced that there only remained for discussion the 14th proposal of the Programme, viz. :

"The Committee propose to organise, in connexion with the Congress at Rome, an exhibition as complete as possible of the instruments of observation used in the different countries, and they request meteorologists to contribute thereto by sending either instruments or designs to Rome, *Bureau Central Météorologique, Ministère d'Agriculture.*"

Mr. SCOTT remarked that Captain Hoffmeyer ought to congratulate himself upon the result that his proposal for an exhibition of instruments, made to the Permanent Committee in 1876, had had, and in the name of the Meteorological Council of the United Kingdom, he presented to the Meteorological Office of Italy the collection of British instruments which were in the Exhibition. He expressed the hope that the Central Institutions would exchange specimens of their instruments.

M. WILD presented the photographs of his self-registering instruments to the Meteorological Office of Italy.

M. BLASERNA supported the idea of a complete collection of instruments at the principal offices.

Finally, on the proposal of Mr. SCOTT, the Congress adopted the following resolution :—

"*The Congress expresses the opinion that it is desirable that the*

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central institutions should possess specimens of the principal instruments actually in use in other countries."

Mr. SCOTT announced that the International Meteorological Committee had that day held its first meeting.

M. Wild had been elected President, and Mr. Scott Secretary.

All communications were to be addressed to the Secretary at 116, Victoria Street, London.

Captain HOFFMEYER requested the Committee to make known to meteorologists interested the time of its meetings.

The Congress entrusted its President and Secretaries with the confirmation of protocol of the present meeting. It entrusted the International Committee with the editing of the report of the Congress in the three languages, English, French, and German.

M. VON BEZOLD proposed that there should be an Italian edition.

M. BLASERNA did not think that necessary.

The Congress directed the Committee to deposit at the Meteorological Office of the Ministry of Agriculture, &c. at Rome, the original protocols, with a complete set of all reports, &c.

Mr. SMITH, in the name of the foreign delegates, requested permission to express to the Italian delegates the most sincere thanks for the kind and cordial welcome which they had received, and for the magnificent manner in which the Congress had been treated by the Italian Government.

M. CANTONI assured the Congress that his fellow-countrymen were truly sensible of the honour which the Congress has done Italy by its visit.

M. BRUHNS proposed a vote of thanks to the President, the two Vice-Presidents, and the two Secretaries.

Mr. SCOTT replied.

The PRESIDENT declared the Meteorological Congress of Rome closed.

The meeting rose at 5h. 30m. p.m.

Approved.

G. CANTONI.

Subsequent to the close of the Congress the following documents were received :—

April 25. A letter from Madlle. Dove, of April 22, expressing the deep sense of gratitude of the family of her late father for the resolution adopted by the Congress at its first meeting (p. 4.)

April 25. A telegraphic despatch from General Myer, from Turin, announcing his arrival in Italy.

April 26. A printed note by M. Brault (who had been unwell during the last days of the Congress) on the construction of synoptic charts.

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APPENDIX I.

List of Delegates.

Austro-Hungary -	J. Hann - -	Director of the I. R. Central Meteorological Institution, Vienna.
(For Austria) -	J. R. Lorenz von Liburnau.	Councillor at the Ministry of Agriculture, Vienna.
	F. Paugger - -	Director of the Academy of Commerce and Navigation.
	C. Weyprecht -	Lieutenant Imperial Navy.
	R. Müller - -	Director of the I. R. Hydrographic Institute, Pola.
(For Hungary) -	G. Schenzl - -	Director of the Observatory at Buda-Pesth.
Bavaria - -	W. von Bezold -	Professor at the Polytechnic School and Director of the Central Meteorological Observatory, Munich.
Belgium - -	J. C. Houzeau -	Director of the Royal Observatory, Brussels.
Denmark - -	N. Hoffmeyer -	Director of the Royal Meteorological Institute, Copenhagen.
France - -	Hervé-Mangon -	President of the Council of the Central Meteorological Office.
	E. Mascart - -	Director of the Central Meteorological Office.
	A. Brault - -	Director of the Nautical Meteorological Office of France.
Germany - -	G. Neumayer -	Director of the Deutsche Seewarte, Hamburg.
	C. Bruhns - -	Director of the Royal Observatory, Leipzig.
	A. Auwers - -	Perpetual Secretary of the Royal Academy of Sciences, Berlin.
Great Britain -	H. J. S. Smith -	Chairman of the Meteorological Council, London.
	R. H. Scott - -	Secretary to the Meteorological Council, London.
Greece - -	D. Kokides - -	Professor of Astronomy at the University of Athens.
Italy :		
Ministry of Public Instruction.	P. Blaserna (President).	Director of the Royal Physical Institute, Rome.
	L. Palmieri - -	Senator; Director of the Observatory, Vesuvius.
Ministry of Agriculture and Commerce.	F. Denza - -	Director of the Meteorological Observatory, Moncalieri.
	P. Tacchini - -	Astronomer at the Royal Observatory, Palermo.
Ministry of Public Works.	A. Baccarini -	Inspector of Civil Engineers, Deputy of the Italian Parliament, formerly Minister of Public Works.
	F. Salvatori -	Inspector-General of Telegraphs, Rome.
Ministry of Marine	G. B. Magnaghi -	Director of the Hydrographic Office, Genoa.
	C. Pittei - -	Director of the Nautical Meteorological Office, Florence.
	G. Cantoni - -	Senator, Director of the Central Meteorological Office.
Netherlands -	H. Snellen - -	Director of the Royal Meteorological Institute, Utrecht.
Norway - -	H. Mohn - -	Director of the Royal Meteorological Institute of Norway, Christiania.
Portugal - -	J. C. de Brito-Capello	Director of the Observatory of the Infante D. Luiz, Polytechnic School, Lisbon.
Russia - -	H. Wild - -	Director of the Imperial Central Physical Observatory, St. Petersburg.
Spain - -	A. Aguilar - -	Director of the Royal Observatory, Madrid.
	C. Pujazon - -	Director of the Observatory, San Fernando.
Sweden - -	R. Rubenson -	Director of the Royal Meteorological Institute of Sweden, Stockholm.
Switzerland -	E. Plantamour -	Director of the Observatory, Geneva.
United States -	A. Myer - -	Brigadier-General, Chief Signal Officer, U. S. A.

Dr. G. Hellmann -	Delegate-Adjunct for Prussia.
Prof. Mendeleef -	Delegate of the University, St. Petersburg.
Prof. C. Weihrauch -	Delegate of the University of Dorpat.
Prof. K. W. Zenger -	Delegate of the Polytechnic School, Prague.

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APPENDIX II.

Byelaws for the Second International Meteorological Congress, 1879, proposed by the Permanent Committee.

Sec. 1.

The Congress consists of the delegates appointed by the Governments.

If one of the Members of the Congress makes such a proposal and the meeting adopts it, Visitors may be allowed to be present at the sittings, but they can only take part in the discussions without the right of voting.

Sec. 2.

The Opening of the Congress and the Election of the Bureau.

The President of the Permanent Committee appointed at the Congress of Vienna, or if the President is prevented, one of its Members who is present, and is selected by the Permanent Committee, shall open the first meeting of the Congress, shall submit the Byelaws for approval, and shall propose the election of a Bureau, consisting of a President, two Vice-Presidents, and two Secretaries. These elections shall be made by the absolute majority of the Members of the Congress, delegated by the Governments, who are present at the meeting.

Sec. 3.

The Functions of the President.

The President shall fix the day and hour of the General Meetings. With the concurrence of the Bureau, he shall determine the *agenda* for each meeting. The order of the day should be announced by the President at the commencement of each meeting. The President shall direct the debates and provide for the maintenance of order at the General Meetings. The President shall propose to the Congress the names of the Members of the Committees to which is referred the preparation of the different subjects of the Programme. (Sec. 6.)

Sec. 4.

The Programme of the Deliberations.

The Programme prepared by the Permanent Committee, in accordance with the instructions of the Congress of Vienna, shall serve as a basis for the deliberations. Each Member of the Congress is free to make proposals. With reference to new subjects which are to be brought under discussion, such proposals are to be referred to a Committee, which is to report at one of the subsequent meetings. (Sec. 6.)

Sec. 5.

The Report of the Permanent Committee.

The President will request the Permanent Committee appointed by the Congress of Vienna to present a Report on its action, and to submit to the Congress all the manuscript and printed communications which it has received. As soon as this is done, the functions of the Permanent Committee cease, and its powers are replaced in the hands of the Congress.

Sec. 6.

The Sub-Committees and their Formation.

The various questions of the Programme will be referred to special Committees. The Members of the different Committees are appointed by the Congress on the proposal of the President.

Each Member of the Congress (Sec. 7) is entitled to attend any of the Committee meetings, but without the power of Voting.

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SEC. 7.

The Constitution of the Committees.

At the close of each General Meeting the Committees which have been nominated at the Meeting shall constitute themselves by proceeding to the election of a President, a Reporter, and a Secretary.

The President of each Committee shall immediately fix the hour and place of the next Meeting of the Committee.

SEC. 8.

The Method of Voting.

In divisions at the General Meetings the absolute majority of the delegates present shall decide. In the case of equality, the vote of the President shall decide.

If, however, any delegate demands it, a division may take place according to countries. The countries which have less than 10 millions of inhabitants shall have *one* vote; the countries which have from 10 to 30 millions of inhabitants shall have *two* votes; the countries which have more than 30 millions of inhabitants shall have *three* votes. The delegates of each country must come to an understanding among themselves to decide which of them shall be charged with giving the vote of their country.

SEC. 9.

The Protocols of the General Meetings and the Report of the Proceedings of the Congress.

The Protocols of every General Meeting should be read and confirmed either at the end of the Meeting or at the commencement of the next.

The publication of the Report of the Proceedings, as well as the printing, and distribution of the Protocols, should be entrusted to the Permanent Committee (Sec. 10), or to a Special Committee.

SEC. 10.

The Election of the Permanent Committee.

For the interval between the present Congress and the next, the Congress shall choose by ballot the Members of a Permanent Committee, which shall constitute itself by the election of a President and a Secretary.

APPENDIX III.

PROGRAMME.

The Permanent Committee, charged by the First International Congress of Vienna with the adoption of preliminary measures for the convening of a second meeting of the same nature, in carrying out the commission entrusted to them, hope that the new Congress, starting from the results which have been already obtained by the first, will not only carry on further the uniformity which is so important for Meteorology, but also will contribute materially to the development of Meteorology in other directions by promoting mutual investigations on a large scale. In order that, on its part, nothing should be omitted which could contribute to the attainment of this end, the Committee has deemed it specially important to prepare carefully the materials for discussion for the future Congress in the following way,—by proposing, once for all, a detailed Programme of proceedings, and by requesting certain special persons to prepare Reports on complicated questions and submit them to the Congress.

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The following is the programme of questions to be discussed, which the Committee, after consultation with the delegates to the First Congress, has definitely adopted:

1. Regulations for the Second International Congress of Meteorologists.
Scheme to be drawn up by M. Bruhns.

2. Report of the Committee on their action during the interval between the First and Second Congress.
To be drawn up by Mr. R. H. Scott, the Secretary to the Committee.

3. Report on the conformity with each other, and with the decisions of the Congress of Vienna, of instruments, methods of observation, and publication of observations in the different countries.

4. M. Buys Ballot is requested to prepare a report on the methods employed in the different countries for obtaining true Daily Means from the various combinations of hours of observation.

Proposals made by the Committee.

5. The Committee proposes the general adoption of the forms of publication already introduced in several countries for observations at a certain number of stations of the second order, chosen in each country as International Stations. (See the Reports of the Committee for 1873 and 1874, p. 9, Third Meeting at Utrecht, and Appendix F.)

6. The Committee recommends the general adoption of the code of figures for Meteorological Telegrams proposed at its fourth meeting at Utrecht. (See the above Reports, pp. 12 and 14.)

7. The Committee is of opinion that it is impossible at present to compile general Instructions adapted in their details to the special peculiarities of all countries and all climates. It proposes, therefore, that the Congress should confine itself, in the case of any one demanding typical Instructions, to designating those of the existing Instructions which are most conformable to the decisions of the Congress.

8. The Committee proposes to establish, by small annual contributions from all countries taking part in the Congress, an International Fund, for the expenses incurred by such joint undertakings as those named in the following sections, and the expenses of postage and printing for the Congress and its Permanent Committee.
M. Bruhns is requested to draw up a special proposal on this subject.

9. The Committee requests the delegates to prepare for the Congress at Rome a catalogue of the Meteorological Observations, both published and unpublished, in their respective countries.

10. The Committee proposes to have a comparison made of the standard barometers and thermometers of all the Meteorological Institutes, by referring them to a certain barometer and thermometer which, for the time being, appear to be the best verified. Inasmuch as the International Office of Weights and Measures of Paris will be in possession of such verified standard instruments, a comparison should be instituted with them, and they should serve as a basis for all corrections. At the same time any questions about accurate height above sea level of standard barometers should be raised.
M. Wild is requested to draw up a detailed proposal on this question.

11. The Committee draws attention to the importance of establishing distant stations and supplying them with the necessary instruments.

12. The Committee is of opinion that the establishment of an International Meteorological Institute is at present not possible, nor even desirable, and proposes to provide for the functions and labours which might devolve upon such an institution in the following manner:—

(*a.*) The International administrative functions, such as the execution of the decisions of the Congress, the convening of future Congresses, the care of joint international investigations and undertakings, the administration of the international fund, &c., will be confided, as is already partly the case, to a *Permanent Committee* elected from time to

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time by a Congress and required to give an account of its action to the next Congress.

(*b.*) As regards researches which embrace a considerable portion of the globe for the purpose of deducing general laws in Meteorology, it is desirable that permanent relations for the communication of materials should be established between the different central institutes, and that the publications appearing in each country should be distributed gratuitously to all institutes and to all persons who take part in the investigations. These publications are to be, moreover, rendered generally accessible through the agency of booksellers. These international investigations will be based upon the publication of the observations of each country according to the international form, and besides on the special labours which each country may be willing to undertake with regard to its own climate. In the case of supplementary information being required for any countries, it is desirable that a suitable system of reciprocal communications should be devised.

13. The Committee considers the following subjects as possessing a general interest:—

(*a.*) The critical collection and discussion of all existing data on the Diurnal and Annual Range of Air Temperature, and attempts to deduce general laws therefrom.

(*b.*) The critical collection and discussion of all existing data on the Diurnal and Annual Range of absolute and relative Atmospheric Humidity, and attempts to deduce general laws therefrom.

(*c.*) The critical collection and discussion of all data on the Diurnal and Annual Range of the Amount of Cloud.

(*d.*) Wind tables for the 12 months and for the year.

(*e.*) Tables of Precipitation " "

(*f.*) New tables of Atmospheric Pressure, with isobars, for the 12 months and for the year.

(*g.*) Charts of the Movements of Storms.

(*h.*) Daily Synoptic Charts, embracing considerable portions of the globe. (See Art. 34).

14. The Committee proposes to organise, in connexion with the Congress at Rome, an exhibition, as complete as possible, of the instruments of observation used in the different countries, and it requests Meteorologists to contribute thereto by sending either instruments or designs to Rome (*Bureau Central Météorologique, Ministère d'Agriculture*).

15. The Committee recommends the establishment of rules and formulæ for reducing barometric readings to the sea level in a uniform manner.

M. Bruhns is requested to draw up a report upon the subject.

16. The Committee proposes the establishment of uniform rules for determining the fixed points of thermometers.

Messrs. Pernet and Balfour Stewart are requested to draw up reports and proposals upon this matter.

Questions.

17. Can definitive rules now be established for the most suitable Exposure of Thermometers destined to give the Temperature of the air?

MM. Buchan and Köppen are requested to draw up reports on this subject.

18. Have additional comparative experiments been made since the first Congress for forming an opinion of the different methods for determining Earth Temperature, which give more definite information as to their relative value?

MM. Ebermayer and Everett are requested to draw up reports on this subject.

19. Have decisive experiments been made since the First Congress to find a simple and appropriate method for determining Radiation, and what is the relation between this and the amount of Aqueous Vapour in the atmosphere?

M. Violle is requested to draw up a report on this subject.

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20. What progress has been made in methods for determining the Humidity of the air?

MM. Alluard and Cantoni are requested to draw up reports.

21. What progress has been made in the methods of determining Evaporation?

Messrs. Cantoni and Ebermayer are requested to draw up reports on this subject.

22. Is there any reason to change, after further experience, the decisions of the First Congress respecting the instruments and methods for measuring the quantity of Rain or Snow?

M. Mohn has published a report.

23. How may absolute values of the Velocity of the Wind be deduced from the direct indications of different anemometers?

M. Hoffmeyer is requested to draw up a report.

24. Have, since the last Congress, better methods been discovered for measuring the Ozone in the atmosphere?

25. What progress have the methods for determining Atmospheric Electricity made, and what results have observations of this kind furnished hitherto?

Mr. Everett has already published a report, and MM. Cantoni, Mascart, and Sohncke are requested to draw up reports upon this question.

26. Have, since the last Congress, Hourly Meteorological Observations been made at new, and especially Continental, stations within the Tropics? (See Report of the IVth Commission, Protocol of the Sixth Meeting of the Congress of Vienna, and its First Supplement.)

Mr. Blanford is requested to draw up a report.

27. What progress has Meteorological Telegraphy made since the first Congress, and how can we contribute to its development?

Mr. Scott has published a report, and M. Neumayer is requested to draw up a report thereon.

28. What progress has Maritime Meteorology made since the first Congress?

Mr. Scott has published a report, and M. Neumayer is requested to draw up a report thereon.

29. What results have the Simultaneous Observations given, and how may we contribute to their further development?

M. Buys Ballot and General Myer are requested to draw up reports.

30. What observations do we possess from high mountains and from balloon ascents, and what measures should be taken to organise these observations more completely?

M. Hann is requested to draw up a report thereon.

31. The Committee, after having taken cognizance of the project of M. Weyprecht to establish several observatories in the Arctic and Antarctic regions, so as to organise hourly Meteorological and Magnetical Observations to be made simultaneously all around the Pole, is of opinion that those observations will be of the highest importance in developing Meteorology, and in extending our knowledge of Terrestrial Magnetism. It thinks, therefore, that, in the interest of science, they should recommend general participation in this enterprise. In what manner can the Congress, on its part, contribute to the success of the enterprise?

M. Mohn has submitted his proposals. M. Buys Ballot has promised a report; and M. Neumayer is requested to submit any he may wish to make.

32. In what manner should we proceed to establish Meteorological Stations in distant countries where observations have not hitherto been made?

M. Mohn has published his views, and Mr. Parkinson has made a proposal (regarding the South Pacific).

33. Should we not recommend the general adoption of a certain First Meridian, for example, that of Greenwich, for Synoptic Charts?

M. Bruhns is requested to draw up a report.

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34. In what manner can we best organise and develop the construction and publication of Synoptic Charts embracing considerable portions of the globe?
M. Hoffmeyer is requested to draw up a report on this question.

35. How can the development of Meteorology in connexion with Agriculture and Forestry be forwarded by the Congress?

N.B.—The Committee think that, in order to avoid misunderstanding, they should expressly state that the request to certain persons to draw up reports on any questions does not exclude other persons from making such reports on the same questions, but that their object is solely to secure *at least one* report in all cases upon the questions indicated. On the other hand, it seems very desirable that other Meteorologists should treat the subjects in question, in order that the Congress may possibly see them treated from different points of view. With this object the Committee has named several gentlemen as reporters on the different questions. All persons who may be willing to undertake such reports are requested to address them to the Secretary of the Committee (Mr. R. H. Scott, Secretary of the Meteorological Office, 116, Victoria Street, London, S.W.), before the end of January 1879, and, if possible, themselves to have them published in several languages, so that on the one hand the Committee should be better able to prepare the materials for discussion for the Congress, and on the other hand that the reports may be brought to general knowledge and consideration before the opening of the Congress.

Utrecht, October 18th, 1878.

Buys Ballot, President, Utrecht,
R. H. Scott, Secretary, London,
For the Permanent Committee of the First Meteorological Congress at Vienna.

APPENDIX IV.

Report of the Permanent Committee.

Introductory.

Immediately on its appointment in 1873, and before the members of the Permanent Committee had left Vienna, a preliminary meeting was held to constitute the organisation of the Committee, and to determine upon a course of action. Three meetings have since been held; one in Utrecht in September 1874; one in London in April 1876; and one again in Utrecht in October 1878. The reports of each of these several meetings have appeared in French, German, and English, and are in the hands of the present Congress.

References to the Committee.

The subjects specially referred to the Permanent Committee by resolutions of the Vienna Congress were seven in number, and appear in the following order in the report of that meeting.

Resolution 21.—The International Telegraphic Code.
„ 22.—Maritime Meteorology.
„ 24.—General Instructions for all Stations.
„ 25.—The preparation of Normal Standard Instruments.
„ 26.—The Scheme of publication for Stations of the Second Order.
„ 28.—The constitution of the Permanent Committee itself.
„ 29.—The Proposal for an International Meteorological Institute.

In addition four proposals were referred to the Permanent Committee by the Congress.

1. Professor Buys Ballot for the establishment of an International Fund.
2. Dr. Jelinek, for the collection of information on existing Meteorological Systems.
3. Dr. Jelinek, for the collection of information on existing records of observations.
4. General Myer for the organisation of simultaneous observations.

It will be convenient to consider Resolution 28 first, as it refers to the action of the Committee itself.

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The resolution runs as follows:

"To express to the different Governments the wish that a new international Congress should be convoked in three years' time.

"In the meantime to determine on the appointment of a Permanent Committee.

"The Committee should consist of seven members chosen by the present Congress, and it has the power to fill up the places of members who resign, and eventually to increase itself by the co-option of two members at most.

"The President shall also be chosen by the present Congress.

"The Committee will have the duty of taking care of the carrying out of the decisions of the Congress, and of arranging for the convening of a future Congress; and it shall, by continual communications, place the delegates of the present Congress in cognizance of its action and proceedings."

Constitution of the Committee.

The Committee has exerted the right of co-option, originally conferred upon it, by the nomination of M. E. Mascart, Directeur du Bureau Central Météorologique de France, as representative of France on the Committee. It has not thought it expedient to co-opt another member. It has, however, had to deplore the loss by death of one of its most valued members, Hofrath Dr. Carl Jelinek, in October 1876; but it has esteemed itself fortunate in being able to fill the vacant place by the election of Dr. Julius Hann, the worthy successor of Dr. Jelinek in the important office of Director of the Austrian Meteorological System.

Representative for France.

Death of M. Jelinek.

Election of Dr. Hann.

Appointment of a secretary.

A slight change in the organisation originally contemplated at Vienna was made at the first meeting of the Committee at Utrecht, by the appointment of Mr. Scott as Secretary, to assist the President in the issue of circulars, and in the management of the correspondence connected with the business of the Committee.

The Committee has not thought it necessary to publish annual reports of its action as originally proposed, but, as already explained, has issued Reports corresponding to each of its several meetings.

The other references to the Committee will now be considered *seriatim*.

Resolution 21.

International telegraphic code.

"The existence of a system of Weather Telegraphy in every country is declared to be a necessity.

"The report of the Congress contains detailed suggestions on the principles and practice of Weather Telegraphy, and a special report on the subject has been published.

"The Permanent Committee is commissioned to propose a uniform system of cypher for Weather Telegraphy, and to circulate it amongst the directors of the several Central Institutes."

A scheme was proposed at the meeting in 1874, and approved, as described in the Report of the Permanent Committee for that year. It has since been very generally adopted in Europe, as appears from the Report on the subject of Weather Telegraphy presented to the present Congress.

At the same time the Committee would point out that Dr. Hann and M. Rikatcheff have recently made proposals for slight modifications of this code.

The Report of the Committee appointed at the Leipzig Conference in 1872, on the subject of Weather Telegraphy and Storm Warnings, has been published in full in English and German, and a copy accompanies the present Report.

Resolution 22.

Maritime Meteorology.

"The Congress declares it to be very desirable that each country should, if possible, collect all its meteorological observations at one place, in order to undertake the organisation of the investigations at the same place. The Institute should be established as near as possible to the sea.

"The Congress is of opinion that the institute for Maritime Meteorology named in the first proposition, might best be placed under the general management of the Chief Institute of the country.

"In consideration of the fact that it will not be possible to devote to Maritime Meteorology at the present Congress a comprehensive consideration corresponding to its importance, but, on the other hand, as it seems that a mutual understanding of the individual maritime nations in regard thereto is necessary, the Meteorological Congress declares that the convening of a Maritime Meteorological Conference is desirable.

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"The preparation for this Conference is to be entrusted to a Sub-Committee to be named by the Congress."

A conference on the subject was held at the Meteorological Office in London, in August 1874, and was attended by 24 representatives coming from 14 different countries.

The report of the proceedings has been published in English, and a copy accompanies the present report.

The Permanent Committee may point out as an indirect result of the Conference in London, the recent organisation in more than one European country, of special offices for the discussion of Maritime Meteorology as recommended by the Vienna Congress.

Reports on this subject are submitted to the present Congress by M. Neumayer and Mr. Scott.

Resolution 24.

"The Congress recommends the Permanent Committee, if possible by April 1874, to prepare instructions for the institution and discussion of meteorological observations, to distribute them then in separate copies to all members of the Congress, and subsequently, if possible, after paying all possible attention to the remarks which have been received, to proceed, at the latest in June, to edit and publish them definitively." General instructions.

In the programme for the present Congress the opinion of the Permanent Committee is expressed that it is not possible to carry out this resolution.

Resolution 25.

"The Congress recommends all central offices to adopt real standard barometers, *i. e.*, instruments which allow of the determination of atmospheric pressure according to its definition in absolute measure. The Permanent Committee is commissioned to determine the conditions which such an instrument should fulfil. Standard instruments.

"At the same time the comparison by means of good portable barometers should not be rejected, and the Permanent Committee is instructed to investigate the best manner in which the comparison of the standard barometers at the several central offices can be effected.

"The Congress considers it to be the business of each central office to prepare a standard thermometer for itself on scientific principles, and it recommends all central offices to forward all the Kew standard thermometers which they either already possess or will presently procure, to a gentleman to be indicated by the Permanent Committee, who shall be entrusted by it with the careful comparison of all these with each other, and, if possible, also with the Air Thermometer."

Reports from M. Wild on Standard Barometers, and from M. Pernet on Standard Themometers are submitted to the present Congress.

Resolution 26.

"Each director is to choose in his own district a number of stations for international objects, and, for the publication of observations, is to adopt a common form (within the limits laid down by the hours of observations), which form is to be proposed by the Permanent Committee after inquiry from the directors of the central offices." International scheme of publication.

This subject was referred to MM. Jelinek and Wild by the Permanent Committee. The schemes proposed independently by these gentlemen were discussed at the meeting at Utrecht in 1874, and the resulting plan was embodied in the report of that meeting.

In this form it was submitted to the directors of the Central Institutes by circular dated February 19th, 1876.

It has been very generally approved, as is evidenced by its adoption in most European countries. Almost the only objection to it which has been raised has been that contained in the letter of the Scottish Meteorological Society, printed in the report of the Permanent Committee for 1876, to which communication the Committee replied in the body of that report.

The form is now proposed to the Congress for final and definite adoption.

Resolution 29.

"1. The Congress holds the establishment of an International Institution for the advancement of Meteorology as really useful and desirable. The International Institute.

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"2. The Congress furnishes the Permanent Committee with instructions to investigate all the questions bearing on the establishment of this institution and to propose a detailed scheme. The committee should publish the result of its inquiry and proposals in the course of the year 1874, and should disseminate them as widely as possible, so that they can be taken into consideration by a future Meteorological Congress."

This subject has received the most careful consideration of the Committee, and the result of its deliberations is contained in article 12 of the draft programme for the present Congress.

Additional Propositions.

Proposal made by Prof. Buys Ballot:—

The International Fund.

"Should we not express the hope that an International Fund should be established, out of which observatories on islands, and at outlying localities, can be organised and maintained?"

This subject forms article 8 of the draft programme, and a report on it has been prepared by Dr. Bruhns.

Proposals made by Dr. C. Jelinek:—

Reports on existing systems and records.

"The Congress should take into consideration whether it would not be well to request the heads of the various systems of meteorological observations to furnish reports of as uniform a character as is possible, on the organisation of their systems of observation, and especially of their central institution (if there be one), and on the condition of meteorological investigations and publications, as well as on desirable developments and improvements. These reports should be collected and printed in a publication to be selected by the Congress.

"The Congress should take into consideration whether it would not be well in the interest of facilitating meteorological investigations to request the heads of the various systems of observations to state how many long-continued series of observations, printed or not, exist in their respective countries. In the case of printed observations the title of the publication (including publisher's name and the price) should be given, and in the case of unprinted ones, the mode in which either extracts or copies can be procured. For the most important meteorological elements the mean values should be given, with indication of the years from which they have deduced.

"The contents of these communications should be published by a special committee to be chosen by the Congress, and in a manner to be determined by that committee."

The two proposals relative to the collection of information on existing systems of observation and on the condition of the published Meteorological records in each country were embodied in separate circulars printed in the report for 1874, and the replies thereto have been printed in the report for 1876. A suggestion of a similar nature to Dr. Jelinek's second proposal forms article 9 of the present programme.

Simultaneous observations.

At the Vienna Congress a proposal was made by Brigadier General Myer to the following effect:—

"That it is desirable that, with a view to their exchange, at least *one* uniform observation of such character as to be suitable for the preparation of synoptic charts be taken and recorded daily and simultaneously at as many stations as practicable throughout the world."

This was really a revival of a suggestion made more than twenty years previously by Professor Buys Ballot in Poggendorff's Annalen. It has, however, been carried into effect, and a large number of stations, more especially in Europe, have furnished observations taken daily at the appointed epoch of time. The history of the development of this system will be found in the reports of the Permanent Committee. It was at first contemplated by that body that the European simultaneous observations should be made accessible to meteorologists by a special publication, but the extreme liberality of the Government of the United States, in distributing the printed records of these observations gratuitously, has rendered the preparation of a special European publication unnecessary. A report on the subject of simultaneous observations has been prepared by M. Buys Ballot.

Capt. Hoffmeyer's Atlas.

At the same time the Committee has to report to the Congress that it has from the first strenuously supported the undertaking of Captain Hoffmeyer

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to publish, by means of special subscriptions, Synoptic Charts for Europe and the North Atlantic. These charts have been issued for a period of 27 months from September 1873 to November 1875 inclusive, and the Committee understand that their preparation for a period of 12 months further is secured.

It seems unnecessary to enter into particulars as to the proceedings of the Permanent Committee, as these are fully detailed in its three reports which are in the hands of the Congress.

The Committee has prepared Byelaws and a Programme for submission to the present Congress, and it will be convenient to conclude the present report with a notice of the different reports which have been proposed for the Congress. These reports have reference to the following questions: Nos. 3, 4, 8, 10, 15, 16, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35.

3. No person was named for the report on the degree to which the resolutions of the Vienna Congress have been carried out, and no report has been received.
4. M. Buys Ballot has prepared a report "Sur la réduction des moyennes "des observations eu vraies moyennes."
8. MM. Bruhns and Wild have prepared Reports on the International Fund.
10. M. Wild has prepared a report on the Comparison of Standard Instruments.
15. M. Bruhns has prepared a Report on the Reduction of Barometrical Readings to Sea Level.
16. M. Pernet has prepared a report on the determination of the fixed points on thermometer scales. M. Balfour Stewart has declined, considering that it is premature to make any positive statements on the subject.
17. Neither Mr. Buchan nor M. Köppen have as yet prepared reports on Thermometer Exposure, but the Committee has received reports on this question from MM. Cantoni, Capello, and Wild.
18. MM. Ebermayer, Cantoni, and Wild have prepared reports on Earth Temperature. M. Everett regrets to be unable to find time to write a report on the subject.
19. M. Violle has prepared a report on Solar Radiation.
20. M. Cantoni has prepared a report on Hygrometrical Observations. M. Alluard has not furnished one.
21. MM. Cantoni and Ebermayer have prepared reports on Evaporation.
22. M. Mohn has prepared a report on the Measurement of Rain.
23. M. Hoffmeyer has declined to prepare a report on Anemometry, but MM .Capello and Wild have prepared reports thereon.
24. MM. Everett, Denza, and Palmieri have prepared reports on Atmospheric Electricity. None has as yet been received from M. Cantoni, and M. Sohncke has declined to prepare a report.
26. M. Blanford has prepared a report on the Meteorological Stations in Low Latitudes.
27. Mr. Scott has prepared a report on Meteorological Telegraphy; none has as yet been received from M. Neumayer. MM. Hann, Pittei, and Rikatcheff have made certain proposals on the subject to the Congress.
28. Mr. Scott has prepared a report on Maritime Meteorology, and M. Neumayer has prepared one specially referring to the history and state of Maritime Meteorology in Germany. MM. Pittei and Rikatcheff have made some proposals on the subject.
29. M. Buys Ballot has prepared a report on Simultaneous Observations, none has as yet been received from General Myer.
30. M. Hann has prepared a report on the Observations from Mountain Stations and Balloon Ascents.

    The latter subject has been brought under the notice of Aeronautical Societies in accordance with instructions from the Permanent Committee.

    The subject of the increase or decrease of glaciers, which stands in close connexion with Mountain Observations, has been discussed, at the suggestion of Dr. Hann. It has been submitted to the several Alpine Clubs, and replies from the respective secretaries are presented herewith.

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31. MM. Mohn and Buys Ballot have prepared reports on M. Weyprecht's plan for the establishment of Arctic and Antarctic Stations.

Dr. Neumayer has contributed a Memorandum on the Scientific Exploration of the Antarctic Regions.

32. M. Mohn has prepared a report on the possibility of establishing stations in distant localities, and M. Parkinson has submitted, through M. Wild, a proposal for a Meteorological Organisation for the Pacific, with Upolu in the Samoan group as a centre.

33. M. Bruhns has prepared a report on the choice of a First Meridian.

34. M. Hoffmeyer has prepared a report on the construction of Synoptic Charts.

Dr. Neumayer gives an account of an arrangement between himself and Capt. Hoffmeyer on a plan for issuing the Synoptic Charts in future.

35. MM. Bruhns, Denza, and Lorenz have prepared reports on the development of Meteorology in connexion with Agriculture and Forestry.

In connexion with this subject the Permanent Committee would direct the special notice of the Congress to the resolutions of the International Statistical Congress of Buda-Pesth 1876, contained in the Report of the Permanent Committee for 1878.

Proposition of the Fourth Section of the International Statistical Congress at Buda-Pesth in 1876, relative to Agricultural Meteorology.

1. The Congress recommends to the Governments of all countries to institute special observations relative to Agricultural Meteorology, to be afterwards centralized, discussed, and regularly published by the Governments or scientific establishments.

2. The Congress requests the Governments to cause their agents (crop reporters) to send to them monthly reports on the state of vegetation of cereals in their districts.

3. The Congress recommends the Governments to institute observations with the object of ascertaining the influence on climate of the destruction of forests and of planting trees.

4. The Congress expresses the wish that observations relating to thunderstorms, hail as well as periodical phenomena respecting the flora and fauna, may be taken at the greatest possible number of points in each country, and that the results of these observations be centralized, co-ordinated, and published.

5. The Congress expresses the wish that a certain number of meteorological observatories should establish international telegraphic communications between themselves in order to transmit to each other observations, with the view of the establishment of weather forecasts for the benefit of agriculture and commerce. It requests that these observations may be, as far as possible, immediately brought to the knowledge of the crop-reporters and distributed among the public, especially with the object of preventing the effects of frosts, floods, &c.

6. The Congress charges its permanent Committee with the communication of these proposals to the Meteorological Congress which will be held at Rome in 1877, and in case of an understanding being established between the Permanent Committees of the two Congresses, to submit the definitive wish of the Congress relative to agricultural meteorology to the Governments of the different countries.

Cirrus observations.

The Committee would also mention the proposal of M. Hildebrandsson of Upsala, relating to Cirrus Observations, a subject which appears to it to possess very great importance.

The Committee cannot conclude this Report without expressing its heartfelt grief at the irreparable losses which the science has sustained, since the date of the Vienna Congress, in the successive deaths of Jelinek, Le Verrier, Secchi, and even as the Congress is assembling of W. Heinrich Dove, the founder of the entire superstructure of accurate climatological knowledge.

The Committee, with these words, replaces in the hands of the Congress the powers entrusted to it at Vienna in 1873.

ROBERT H. SCOTT,
Secretary to the Permanent Committee.

Rome, April 10th, 1879.

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APPENDIX V.

Extracts from Appendix No. VIII. to Report of Treasury Committee on Meteorology, 1877.*

Information obtained from Replies to Questions contained in Circular addressed to Meteorological Departments in Foreign Countries.†

Question 1.—*How many stations are there in your system?*
(*a*) *How many of the* 1*st order?*
(*b*) „ „ 2*nd* „
(*c*) „ „ 3*rd* „

Austria.—259, (*a*) 5, (*b*) 120, (*c*) 78. Stations only recording quantity of rain, 56.

Hungary.—98, (*a*) 2 including the Central Office, (*b*) 84 (bar., pschr., rain-gauge, &c.), (*c*) 12, (thermom. and rain-gauge).

Baden.—16, (*a*) 0, (*b*) 12, (*c*) 4.

Bavaria.—8 official and several private stations.
(*a*) 1 at Munich Observatory.
(*b*) 7, (*c*) none.

Belgium.—No reply.

Denmark.—177, (*a*) 1, (*b*) 16, (*c*) 160.

France.—No reply.

Hamburg.—At present, 11, projected, 31. At present (*a*) 6, (*b*) 4, (*c*) 1. Projected (*a*) 9, (*b*) 0, (*c*) 4 and 18.‡

Holland.—10, (*a*) 2, (*b*) 3, (*c*) 5, and 30 of the 4th order.

Italy.—82, (*a*) 8, (*b*) 20, (*c*) 54.

Portugal.—16, (*a*) 0, (*b*) 11, (*c*) 5.

Prussia.—No reply.

Russia.—129 at work, (*a*) 8, (*b*) 101, (*c*) 20, beside the 250 rain and weather stations of the Geographical Society.

Saxony.—28, (*a*) 1, (*b*) 20, (*c*) 7.

Sweden.—29, (*a*) 1 (Upsala independent of Central Institute) (*b*) 28, (*c*) none under Central Institute.

Norway.—50, (*a*) 0, (*b*) 32, (*c*) 18 and 130 for thunderstorms alone.

Switzerland.—68. The number, however, varies somewhat from year to year (averages about 70) (*a*) 3, (Geneva, St. Bernard, Berne) (*b*) 45, variable (*c*) 20, variable.

United States.—102. 88 stations make full telegraphic reports; 11 make full observations and report by mail; 3 are printing stations at which meteorological observations are not made. There are besides, 20 river stations under the direction of the Signal Office.

Total of daily reports filed at the Office of the Chief Signal Officer now numbers as follows:

Daily service simultaneous reports - - - -	109
International daily simultaneous reports - - -	268
Reports of voluntary observers - - - -	393
Reports of medical corps of the Army - - -	102
„ „ „ Navy - - -	5
Grand total of daily reports received regularly for discussion - - - - - - - -	877

(Annual Report for 1865, p. 93.)

Canada.—107 stations at present. Volunteer observers are added from time to time, while others drop off. Such of the drum agents as are also regular

* Report of the Treasury Committee appointed to inquire into the conditions and mode of administration of the annual grant in aid of Meteorological Observations. Presented to both Houses of Parliament by command of Her Majesty.

† The information has reference to the year 1876. The statistics as regards England are contained in the body of the Report, and therefore do not find a place in an Appendix to that Report. As regards the United States, no reply to the circular was received from Washington, and the answers to the several questions have been compiled from the published Reports of the Chief Signal Office.

‡ These last 18 will only record wind regularly and barometrical alterations during storms.

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observers are included in the number 107; but there are also 13 drum agents whose reports relate only to storms and storm warnings. (*a*) The Toronto observatory is *in strictness* the only station of the first order, but there are 10 stations which may be regarded as *partially* of the first order. They hold a rank higher than those of the second order, as observations of some of the elements are taken night and day at equal intervals of *three* hours or at equal intervals of *two* hours. Seven of these stations are furnished with anemographs. (*b*) 38, exclusive of the two stations which are partially of the first order. Two of these have anemographs. (*c*) 58.

	(*a*)	(*b*)	(*c*)	Extra.	Total.
AUSTRIA - - -	5	120	78	56	259
HUNGARY - - -	2	84	12	—	98
BADEN - - -	—	12	4	—	16
BAVARIA - - -	1	7	—	—	18
BELGIUM. No reply.					
DENMARK - - -	1	16	160	—	177
FRANCE. No reply.					
HAMBURG { at present -	6	4	1	—	11
HAMBURG { projected -	9	—	4	18	31
HOLLAND - - -	2	3	5	30	40
ITALY - - -	8	20	54	—	82
PORTUGAL - - -	—	11	5	—	16
PRUSSIA. No reply.					
RUSSIA - - -	8	101	20	—	*129
SAXONY - - -	1	20	7	—	28
SWEDEN - - -	1	28	—	—	29
NORWAY - - -	—	32	18	130	180
SWITZERLAND - -	3	45	20	—	68
UNITED STATES - -	88	11	3	20	122
CANADA - - -	11	58	58	—	107

Question 2.—Are these stations at which no self-recording instruments are used, but only eye observations made?

(a) If so, to what purposes are the latter put?

AUSTRIA.—At the five stations of the first order *registering instruments* are used. Eye observations are verified, sometimes reduced, and always kept for reference at the Central Meteorological Institute. The monthly and yearly results, to be used for climatological investigations, are published for all stations in the *Jahrbuch der Central Anstalt.*

HUNGARY.—At all stations eye observations are made; self-recording apparatus exists only at the Central Station of Buda-Pesth and at Agram; in Agram and Buda-Pesth barometer, thermometer, Robinson's anemometer. Besides these are self-recording anemometers in Zeugg and Carlstadt (Croatia).

(*a*) Cistern barometer, psychrometer, rain-gauge, and eventually a wind vane.

BADEN.—No self-recording instruments.

BAVARIA.—At the station of the 1st order some self-recording instruments are to be found.

BELGIUM.—No reply.

DENMARK.—The institute possesses no self-recording instruments.

FRANCE.—No reply.

HAMBURG.—At six stations, including Hamburg, self-recording anemometers are already placed, in three others these will be erected; a barograph is now acting in Hamburg; of the other stations at least three, possibly even seven, will receive barographs.

HOLLAND.—At four stations there are self-recording instruments. (*a*) The eye observations are published as well as the others.

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* In addition to the 250 rain and weather stations of the Geographical Society.

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ITALY.—The stations of the first order are provided with registering instruments for the larger part of meteoric phenomena. Those of the second order are also provided with them, but only for some of the phenomena. The others register only the direct or eye observations.

PORTUGAL.—Yes. (*a*) The observations of the continental stations and from Funchal are published in the daily report of the Government Journal, and in other newspapers. The observations of all the stations are published in the "Annaes do Observatorio do Infante D. Luiz." Those of the three international stations are published in schedules as adopted by the Congress of Vienna.

PRUSSIA.—No reply.

RUSSIA.—The stations of the 1st order have partly self-recording instruments; all stations of the 2nd order make only eye observations, which are published *in extenso* in the annals of the Central Observatory.

SAXONY.—Only at stations of the 1st order are self-recorded observations made; at all others only eye observations.

(*a*) For climatology.

SWEDEN.—Yes, with the exception of Upsala.

NORWAY.—Yes.

(*a*) Printed in Jahrbuch.

SWITZERLAND.—Self-recording instruments, the data of which are published, exist only at Bern. At St. Bernard, and at Geneva, direct observations are made from 6 a.m. to 10 p.m. at intervals of two hours.

UNITED STATES.—No self-recording instruments yet used.

CANADA.—No self-recording instruments, excepting anemographs, are in use out of Toronto. 12 stations report to Toronto three times daily by telegraph for purposes of prognostication. These, as well as those of the (partial) first order, and those of the second order, report weekly by mail; while stations of the third order report by mail monthly. (*a*) The reports received by mail, after examination and intercomparison, are arranged in forms suited for the discussion of various scientific questions. The reports are also employed for tracing out the results of former prognostications.

Question 3.—*What means are taken to ensure correctness at all the stations?*

AUSTRIA.—Correctness is ensured principally by comparing the results of observations made in two or more stations situated in the vicinity of each other.

HUNGARY.—By the distribution of similar verified instruments and the use of the tables of reduction calculated by the Central Office. The instruction is quite analogous to that of the Austrian Organisation.

BADEN.—Yearly tours of inspections.

BAVARIA.—The stations are from time to time inspected and the instruments tested.

BELGIUM.—No reply.

DENMARK.—Annual inspections; frequent testing of instruments by the observers; monthly discussions of the results of the observations with the aid of synoptical charts constructed for pressure, temperature, rain.

FRANCE.—No reply.

HAMBURG.—Regular yearly and also occasional inspections, further control through the daily telegrams and the monthly tables.

HOLLAND.—Continual comparison every month. As soon as a station records an improbable observation I inquire after that. Moreover, I have two different barometers at each place, observed by two different persons.

ITALY.—For the stations of the first and second order the instruments are compared and inspections are made.

PORTUGAL.—Instruments of the same model all compared with the standards of this observatory, where the observers must have one month's practice.

PRUSSIA.—No reply.

RUSSIA.—The instruments are verified at the Central Observatory and the stations inspected from time to time.

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SAXONY.—The instruments are in the first place all verified individually, and by the comparison of the results of the stations one with another a proof is obtained of the correctness of the observations.

SWEDEN.—Examination of the journals sent in, and tours of inspection.

NORWAY.—Inspection. Construction of curves and charts.

SWITZERLAND.—Comparative critical examination of the tables leads to the instant discovery of large and constant errors. Correspondence and inspections.

UNITED STATES.—Frequent inspection, and also examination of returns at Central Office. (See answer to question 9.)

"The course at the school of instruction and practice at Fort "Whipple is intended to furnish a force of selected enlisted men at "once disciplined as soldiers, and fitted by special instruction for the "different special duties of the Signal-Service. There have been "instructed during the year 80 men as assistant observers, and 42 for "promotion to the grade of serjeant. (Report for 1875, p. 3.)

"Special instructions are given in the use of the system of Weather "Reports adopted by this Office, and in the care and management of "stations.

"The number of *Naval* officers fully instructed during the year has "been 12; of the *Army*, 3. In addition to this, 2 officers were "instructed in Meteorology alone, having previously completed the "other part of the course." (Report for 1871.)

CANADA.—Correctness in observations is sought by supplying printed and written directions, by oral instructions through visitors, and by notifying observers by letter whenever errors in their reports are detected.

Question 4.—*How often and at what hours are observations made?*

AUSTRIA.—The observations (with exception of the mere rain stations) are taken three times in the day. It was impossible to induce all observers to choose the same hours. Of the above cited number of 203 observers there observed at 7, 2, and 9, 134 or 66 % at 6, 2, and 10, 14 or 7 % at 7, 2, and 10, 14 or 7 %, at other combinations 41 or 20 %.

HUNGARY.—Three times daily; the combination of hours is various:—

7 a.m.	2 p.m.	9 a.m.
6 „	2 „	10 „
8 „	1 „	8 „

BADEN.—Three times a day, at 7, at 2, at 9.

BAVARIA.—At stations of the 2nd order twice a day; in winter at 9 am. and 4 p.m., in summer at 7 a.m. and at 6 p.m.

BELGIUM.—No reply.

DENMARK.—Ordinarily three times a day (8 a.m. 2 and 9 p.m.)

FRANCE.—No reply.

HAMBURG.—8, 2, 4. and 8 o'clock, of which 4 o'clock is only arranged for telegrams and is not included in the annual publications.

HOLLAND.—At every place three times a day at 8 and 2, and besides at 8 or 10 p.m.

ITALY.—The stations of the first order observe at 6 and 9 a.m., at noon, at 3, 6, and 9 p.m. Those of the second order observe at 9 a.m., 3 and 9 p.m., and make also simultaneous observations with Washington, like those of the first order. The others observe only at 9 a.m. and at 3 and 9 p.m.

PORTUGAL.—Four stations at 9 a.m., 0 and 3 and 9 p.m. Six stations at 9 a.m., 0, and 3 p.m. One station 9 a.m. and 3 p.m. Five stations only at 9 a.m. The International stations (Campo Maior, Angra, Funchal) make further one observation at 7.35. Washington time.

PRUSSIA.—No reply.

RUSSIA.—Three times a day at 7 a.m., 1 and 9 p.m. in stations of the 2nd order.

SAXONY.—Daily at stations of the 2nd order, three times at 6, 2, and 10 o'clock.

SWEDEN.—Three times a day at 8 a.m., 2 p.m. and 9 p.m.

NORWAY.—Three times; 8 a.m., 2 p.m., and 8 p.m.

SWITZERLAND.—Three times. Observations are made at 7 a.m., 1 and 9 p.m.

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UNITED STATES.—The total number of stations from which telegraphic reports of meteoric changes are received *tridaily*, in regular series, is 101. (Report for 1875, p. 88.) The hours of observation are 7 a.m., 2 p.m., and 9 p.m., local time of the stations. (Report for 1874, pp. 88, 89.)

CANADA.— At *telegraph* stations observations are made synchronously at 7.25 a.m., 4.25 p.m.. and 10.50 p.m. (Toronto time), and at some of these stations additional observations are made at 7 a.m., 2 p.m., and 9 p.m. *local* time.

At some of the partial stations of 1st order, observations are at every even hour, and some at every third hour, ending in each case with midnight; while at others where the three telegraph hours are used, six additional observations are taken, so as to form eight equidistant times from 1.25 a.m. to 10.25 p.m.

For other stations the hours preferred and most frequently used are 7 a.m., 2 p.m., and 9 p.m.; but sometimes it is necessary to employ 7 a.m., 1 p.m., and 9 p.m. and in a few cases, other combinations.

Question 5.—*How are the observations recorded? Who supplies the schedules.?*

AUSTRIA.—The observations are recorded in monthly forms or schedules, and these are sent by mail to the Central Institute.

HUNGARY.—The results in the year books. Daily observations only from the two stations, Buda-Pesth and Fiume, in monthly tables. The schedules are supplied by the Central Office.

BADEN.—In our large monthly form (that invented by Dove.) The Central Station at Carlsruhe.

BAVARIA.—In tables drawn up for that purpose.

BELGIUM.—No reply.

DENMARK.—The Institute furnishes lists to the observers, who return them with observations each month.

FRANCE.—No reply.

HAMBURG.—Day-books for the first entry of the observations at the instrument, and monthly tables are furnished by the Observatory, a sample of which is enclosed.

HOLLAND.—The Central Office has given the model of the schedules.

ITALY.—In the schedules distributed by the Ministry of Commerce and Agriculture only the observations of 9 a.m., 3 and 9 p.m., and the simultaneous observations are registered.

PORTUGAL.—One schedule per month for every hour of observation furnished by this Observatory.

PRUSSIA.—No reply.

RUSSIA.—Instructions and schedules for observation supplied gratis to all observers by the Central Observatory.

SAXONY.—On tables, the headings of which are lithographed. The schedules are supplied by the Central Station.

SWEDEN.—In printed forms. The Central Institute.

NORWAY.—In schedules, supplied by the Meteorological Institute.

SWITZERLAND.—The observations are recorded in monthly tables, which are furnished by the Central Institute.

UNITED STATES.—Schedules supplied from Central Office.

CANADA.—The schedules are supplied from the Central Office, Toronto.

Question 5a.—If supplied from the Central Office is their cost defrayed from its own funds?

AUSTRIA.—The cost of printing these forms is defrayed by the Central Institute out of its general fund.

HUNGARY.—Funds for this purpose are not supplied. The schedules are defrayed out of the budget of the Central Office, under the title of "Chancery expenses," covering the cost of printing.

BADEN.—All meteorological expenses are defrayed by the Minister of Commerce.

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BAVARIA.—The expense is defrayed at the official stations by the Government.
BELGIUM.—No reply.
DENMARK.—The Institute pays for the lists.
FRANCE.—No reply.
HAMBURG.—Out of the funds of the Marine Observatory.
HOLLAND.—They are supplied partly at the cost of the observers, who have some liberty in the form.
ITALY.—The schedules are given gratis by the Ministry of Agriculture and Commerce,
PORTUGAL.—Yes.
PRUSSIA.—No reply.
RUSSIA.—The Central Observatory.
SAXONY.—Yes, they are paid out of the funds of the Central Station.
SWEDEN.—Yes.
NORWAY.—Yes.
SWITZERLAND.—The cost is defrayed from the credit allowed by the Government.
UNITED STATES.—Expense paid by the State.
CANADA.—Their cost is defrayed by the Central Office.

Question 6.—*Are the observers paid? and if so, at what rate?*

AUSTRIA.—The observers are voluntary and not paid. There are some few observers at stations on mountains (persons employed at mining works) who receive a very small allowance of about 3*l.* 12*s.* a year.
HUNGARY.—No; participation is voluntary; only at certain military hospitals and at the imperial stud farms there are official observers. As remuneration 100*l.* a year is allowed, which is divided between 20 observers.
BADEN.—Certain observers are voluntary, but the majority are paid. Those who observe *all the Meteorological Elements and carry out the subsidiary calculations* are paid 18*l.* a piece. Those who only observe 13*l.* 8*s.*
BAVARIA.—At the Official Stations each observer receives 12*l.* 10*s.* a year.
BELGIUM.—No reply.
DENMARK.—Observers of the second order are paid at the rate of 7*l.* per annum.
HAMBURG.—At various rates: the normal payment is about 15 guineas. The three head agents of the Marine Observatory, who are also otherwise employed, receive 140*l.*
HOLLAND.—The observers are not paid by the Central Office. Only a small present is given to some of them.
ITALY.—The greater part of the meteorological observatories being of private foundation, the State incurs no expense for them. It only gives instruments sometimes, by way of encouragement, gratuitously. The stations of the first order and some annexed to the astronomical observatories or to the universities, are completely at the charge of the Ministry of Public Instruction.
PORTUGAL.—Directors, gratis; observers, 2*l.* per month.
PRUSSIA.—No reply.
RUSSIA.—The observers in stations of the first order are paid from 34*l.* to 115*l.* a year. In the ports the observing marine officers receive from 42*l.* to 75*l.* a year. The observers in stations of the second order are, only in exceptional cases, paid from 14*l.* to 21*l.* a year.
SAXONY.—Yes; an observer of the second order of station receives 10*l.* 10*s.*; one of the third order 30*s.* to 6*l.*
SWEDEN.—Yes, 11*l.* 5*s.*
NORWAY.—19 observers are paid 8*l.* a year.
SWITZERLAND.—Certain (about 10) needy observers are paid; such, when they reduce the observations themselves, receive about 4*l.*; the rest, who only send in original observations, about 2*l.*
UNITED STATES.—The observers are non-commissioned officers and privates specially enlisted and instructed for the signal service. The remunera-

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tion for their meteorological and other services, paid out of the appropriated to the army is as follows:

	£
150 sergeants - - -	6,120*
30 corporals - - -	1,080*
270 privates - - -	8,424*

CANADA.—Payments to observers to cover allowances to assistants are as follows:—

At two stations, partially of 1st order (Artillery stations) service gratuitous.

At eight stations partially of 1st order, from 60*l.* to 140*l.*

At 12 telegraph stations from 60*l.* to 86*l.*

These include some also paid as belonging to the former class.

At four Reserve Telegraph stations from 24*l.* to 60*l.* Drum agents, not included in former classes, are usually paid 1*l.* per month.

At remaining stations the observers are not paid.

Question 7.—Who appoints the observers?

AUSTRIA.—Generally persons disposed to make Meteorological Observations apply to the Central Institute, and it is there decided whether the offer has to be accepted or not, considering the situation of the already existing stations.

HUNGARY.—As they observe voluntarily no one appoints them.

BADEN.—The Director of the central station appoints the observers with special regard to Local experience.

BAVARIA.—The head of the central station in connection with the department of Finance.

BELGIUM.—No reply.

DENMARK.—The Institute pays the observers.

FRANCE.—No reply.

HAMBURG.—The Chief of the Admiralty.

HOLLAND.—At some places the observers are appointed and changed by the higher schools, at others by the Waterstaat, &c.

ITALY.—See answer to Question 6.

PORTUGAL.—The Government.

PRUSSIA.—No reply.

RUSSIA.—No reply.

SAXONY.—The Superintendent of the Central Station.

SWEDEN.—The Meteorological Central Institute.

NORWAY.—The Institute.

SWITZERLAND.—The Meteorological Commission of the Swiss Society for Natural Science. (Naturforscher Gesellschaft.)

UNITED STATES.—Chief Signal Officer appoints those who are at the stations established and supported by the State.

CANADA.—The observers, in nearly every case, are selected by the superintendent, subject to the approval of the Marine Department.

Question 8.—Can they be changed?

AUSTRIA.—They change rather too often, because after a certain lapse of time the work of taking three daily observations becomes tiresome to the greater part of the observers. In some, but rare, cases observers are dismissed by the Central Institute if the observations sent in show signs of neglect or falsification of the registers by putting in interpolated instead of observed readings.

HUNGARY.—They cannot be changed; that is to say, not officially from one station to another.

BADEN.—Yes.

BAVARIA.—Yes, if necessary.

BELGIUM.—No reply.

DENMARK.—The Director alone is independent.

FRANCE.—No reply.

* Calculated at 5 dollars to the £.

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HAMBURG.—Yes.
HOLLAND.—At some places the observers are appointed and changed by the higher schools, at others by the Waterstaat, &c.
ITALY.—See answer to Question 6.
PORTUGAL.—Yes.
PRUSSIA.—No reply.
RUSSIA.—All paid observers can be changed at the direction of the central observatory.
SAXONY.—Yes, whenever the observer proves not to be trustworthy.
SWEDEN.—Yes.
NORWAY.—Yes.
SWITZERLAND.—Yes, but if they have observed faithfully for 3 years, then the instruments become their property.
UNITED STATES.—Observers at the State Station can be changed by the Chief Signal Officer.
CANADA.—Observers can be *dismissed*, but it is not always practicable to *change* an observer, on account of the impossibility sometimes of finding another resident suitable for the duty. This trouble will be removed when the proposed staff of disposable observers has been organised.

Question 9.—How often are the stations inspected?

AUSTRIA.—The great drawback of our organisation has been that till the present time inspections could have been carried out very rarely. The reasons for it were insufficiency of the staff at the Central Institute and want of funds destined for the expenses connected with the inspections.
HUNGARY.—Every year a fixed No. of stations, 15–20 are inspected, the instruments compared, and their condition investigated.
BADEN.—Once a year.
BAVARIA.—About every 2 years on an average.
BELGIUM.—No reply.
DENMARK.—The Stations of the 1st and 2nd order annually; the others successively.
FRANCE.—No reply.
HAMBURG.—Every year.
HOLLAND.—As often as it appears to me necessary from the records.
ITALY.—It has been settled that the stations of the two first classes shall be inspected every two years.
PORTUGAL.—They must be inspected once every three years.
PRUSSIA.—No reply.
RUSSIA.—Irregularly; partly according to existing requirements, partly by employing what opportunities offer.
SAXONY.—Every year.
SWEDEN.—At present about every three years and oftener if necessary.
NORWAY.—Some every year, at least every fourth year (in the North of Norway).
SWITZERLAND.—Every two or three years.
UNITED STATES.—The constant and exact work required at the numerous stations now connected with this Office, renders it necessary that each station should be frequently and minutely inspected, the books and papers examined, and the instruments compared with standard instruments. Each station ought to be inspected at least once in each period of six months.

Eighty-one stations have been inspected during the fiscal year; 10 of these, upon the lakes, were inspected twice. Paper 8 shows the date of each inspection, and the names of the stations inspected. (Report for 1875, p. 103.)

CANADA.—While the importance of frequent visitation is fully recognised (*see* Fourth Annual Report of Superintendent of Canadian Meteorological Office), and it is proposed, when practicable, that all stations should be visited *at least* once in each year, the magnitude of the territory concerned, extending from Newfoundland to Vancouver, and northwards beyond the Arctic circle, and the insufficiency of the present staff, have

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hitherto made proper visitation impracticable. The more important stations have not been visited, on an average, more than once each year, while many have never yet been visited.

Question 10.—*By what persons and at whose expense?*

AUSTRIA.—It is the Superintendent (Director) of the Central Institute who has to decide whether he himself or other persons of the staff have to inspect a given group of stations. The costs are defrayed out of the general funds. ("Dotation" annually granted to the Central Institute.)

HUNGARY.—Usually by the Director and generally in connexion with magnetic determinations of locality. In Buda-Pesth a yearly sum of 50*l.* for general expenses.

BADEN.—By the Director of the Central Station or a Deputy.

BAVARIA.—By the Head of the Central Station, or by his assistants at the Expense of the Government.

BELGIUM.—No reply.

DENMARK.—By the Director or by an assistant. The Institute pays for the journeys.

FRANCE.—No reply.

HAMBURG.—At the expense of the observatory by one of its officers.

HOLLAND.—At the expense of the Central Office by the Director of the observations.

ITALY.—At present no certain information can be given on this point.

PORTUGAL.—By the observers of this observatory and from its funds.

PRUSSIA.—No reply.

RUSSIA.—By officials of the Central Institute, occasionally also by scientific travellers, at the expense of the Central Institute or of special Government allowances.

SAXONY.—By the Superintendent out of the funds.

SWEDEN.—One of the officers at the expense of the Central Institute.

NORWAY.—The Director or the first assistant at the expense of the Institute.

SWITZERLAND.—By members of the Meteorological Commission, or by the head of the Meteorological Office at the cost of the nation.

UNITED STATES.—Lieutenants Grugan, Greely, and Gibbon have been employed upon this duty; the former throughout the entire year; Greely, until transferred to other duty; Gibbon, until his relief from signal duty. (Report for 1875, p. 103.)

CANADA.—The stations are visited by the superintendent or by one of his assistants, and at the cost of the Central Office.

Question 11.—*Who supplies instruments?*

AUSTRIA.—With regard to the limited funds granted to the Central Institute, it is endeavoured to have the instruments provided at the cost of the observers. This is especially the case if the observations are to be made at a public school or institution, or by persons known to be in wealthy circumstances. In the greater part of cases, however, if the observers are poor or not willing to buy the instruments themselves, these are lent to the observers by the Central Institute.

HUNGARY.—The Central Office. Out of the budget a sum of 200*l.* is set aside yearly for this purpose.

BADEN.—The Central Station at the expense of the Ministry of Commerce. The voluntary observers have supplied a great many instruments at their own expense.

BAVARIA.—On the recommendation of the superintendent of the Central Station through the Department of Finance.

BELGIUM.—No reply.

DENMARK.—Ordinarily the Institute. A considerable number of the stations of the third order have been organised by private persons who have paid for the instruments delivered by the Institute.

FRANCE.—No reply.

HAMBURG.—The Marine Observatory.

HOLLAND.—If I can obtain the instruments from others, I am very glad; if not, I supply them myself.

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ITALY.—See answer to Question
PORTUGAL.—This observatory.
PRUSSIA.—No reply.
RUSSIA.—Partly the Central Institute, partly the Marine, partly societies and private persons.
SAXONY.—The Central Institute.
SWEDEN.—The Central Institute.
NORWAY.—The Institute. A few barometers are supplied by the telegraph director, viz., for reporting stations.
SWITZERLAND.—The Meteorological Commission. They are furnished by Hermann and Pfister, opticians in Berne.
UNITED STATES.—The work in the instrument and model room referred to in former reports has been continued. 521 Meteorological instruments have been compared during the year with the standard instruments in the Office, and 450 have been issued thence after comparison. (Report for 1875, p. 102.)
CANADA.—The instruments are usually supplied *on loan* by the Central Office; but sometimes they have been purchased by observers through the Central Office, and, in a very few cases, through other channels.

Question 11*a*.—*Are they verified before or after erection?*

AUSTRIA.—The instruments are always verified at the Central Institute before sending them to the stations, and they are again verified at the place of the station if an opportunity presents itself.
HUNGARY.—Yes; the barometers (cistern) by 20 comparisons. Thermometers are usually only tested at the zero point.
BADEN.—They are compared with the travelling instruments on the tour of inspection.
BAVARIA.—Verified before erection.
BELGIUM.—No reply.
DENMARK.—The instruments are always regulated with the normal ones of the institute before they are sent out, and the new stations are inspected as soon as possible.
FRANCE.—No reply.
HAMBURG.—Before erection, later by inspection.
HOLLAND.—Thermometers only before; barometers before and after.
ITALY.—They are verified before distribution.
PORTUGAL.—Before.
PRUSSIA.—No reply.
RUSSIA.—Before; but only for the most part the barometers; afterwards during inspections.
SAXONY.—The instruments are verified before erection and after the erection is completed.
SWEDEN.—Before the sending out and at the inspection.
NORWAY.—Both.
SWITZERLAND.—After erection.
UNITED STATES.—See answer to preceding question.
CANADA.—Instruments from the Central Office are *always* tested before erection, and also occasionally afterwards by visitors. Instruments not passed through the Central Office have in most cases been tested by visitors.

Question 12.—*What staff is employed in the Central Office?*

AUSTRIA.—1 director, 3 adjuncts, 1 assistant, 1 account clerk, 2 calculators, 1 telegraphist, 1 photographer, 1 messenger, 1 gardener, charged at the same time with the functions of a *concierge*. The Government has been asked to grant the employment of a 2nd assistant, and of a person skilled in mechanic's work. The 5 first named form the scientific staff. The position of the adjuncts is a higher one compared with that of the assistant, the former being permanently appointed, the latter for 2 years only (and exceptionally for 6 years). The assistants are taken generally out of the candidates for professorships at middle schools and must have prosecuted their studies at an University or a High Technical School.

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HUNGARY.—The personal staff consists of 1 director, 2 observers (land meteorology), 1 writer and 1 messenger.

BADEN.—One assistant calculator under the superintendent, but this is only a subordinate post for the former.

BAVARIA.—A central office does not yet exist in Bavaria, but will however soon be instituted. The Central Station is at Aschaffenburg.

BELGIUM.—No reply.

DENMARK.—1 director, 2 assistants, draughtsman and calculators, custodian.

FRANCE.—No reply.

HAMBURG.—Division I. (*See* the Instructions of the German Marine Observatory).

HOLLAND.—The director of the observations on land. The director of the section for navigation. The observer at Utrecht.

ITALY.—This office is not yet thoroughly organized, and consequently no information can be given in reply to this question, nor to the following ones as far as the 16th. The Meteorological Direction which superintends the publications is dependent on the Ministry of Agriculture and makes use of its employés.

PORTUGAL.—3 observers, 3 adjuncts, 1 artist photographer, 2 servants.

PRUSSIA.—No reply.

RUSSIA.—Director, his assistant, 4 physicists, 4 observers, 4 calculators, secretary, mechanician, office-keeper. Also free engaged calculator and writer.

SAXONY.—A superintendent. An assistant. A book keeper.

SWEDEN.—2 officers (1 director and 1 amanuensis), several calculators (3 at present) who work at home and 1 servant.

NORWAY.—Director and 4 assistants.

SWITZERLAND.—A head of the office and 2 assistants.

UNITED STATES:

Division of Duties.—The officers on duty at this office are classified as 1st, commissioned officers of the army and acting signal officers who have been announced in orders as "assistants to the Chief Signal Officer;" 2nd, other commissioned officers of the army; and, 3rd, civilian assistants.

The duties of the office are divided as follows:

1. One assistant to the Chief Signal Officer has charge of the orders, records, and general correspondence of the office, critically examining all papers presented him for file, and reporting upon any irregularity. He has also the superintendence of enlistments, and performs such other duties as may be specially assigned to him.

2. One assistant to the Chief Signal Officer has charge, as property and disbursing officer, of all matters pertaining to money and property (all communications upon which subject will be referred to him for action) together with such duties as may be specially assigned to him.

3. One assistant to the Chief Signal Officer has, as instructor, charge of all matters pertaining to the instruction of the signal service of the army, and in addition as "assistant in charge of stations," is charged with the general supervision of the observer-serjeants upon stations, and of the receipt, record, and publication of the weather reports at this office, together with such duties as may be specially assigned to him.

4. The preparation of the current "Synopsis and Probabilities" and of the official publications in relation to practical Meteorology, including the "Weekly Weather Chronicle," "Monthly Weather Review," "Daily Bulletin," "Synopsis," "Probabilities," and "Facts," and such other duties as are related thereto, is divided between the several assistants to the Chief Signal Officer and civilian assistants, in accordance with a roster to be published from time to time, providing in advance for the specified period. In the absence of other orders, the assistant, who at any time may be relieved from the preparation of the current Synopsis and Probabilities, takes charge of the preparation of the publications above alluded to.

5. One officer has charge of the instrument room, and the examination, comparison, and repair of the instruments therein, together with such duties as may be specially assigned to him. He submits a written report to the Chief Signal Officer every ten days on the condition of each instrument, whether its record is satisfactory as a standard; if not, to what extent it

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has been unreliable in its indications, with, if possible, a statement of the cause, and suggestion of the remedy. His duties are more fully specified under a separate section below.

6. Two commissioned officers of the army and acting signal officers will be detailed as inspectors of stations. Their duties are fully set forth in a separate section below.

7. The assistants to the Chief Signal Officer mentioned in paragraphs 1 and 3 of this section will be permanent members of the board convened at this office for the examination of applicants for enlistment, and for instruction in the duties of assistant to an observer on station, and also of the board convened for the examination of candidates for promotion to the grade of serjeant, signal service. Commissioned officers of the army, other than those last above referred to, will, as occasion requires, be detailed to be additional members of each of these boards.

" The probabilities are announcements of the changes considered from " the study of the charts in connection with such rules and generalizations " as the experience of the Office and the study of meteorologists seem to " have determined as probable to happen within the next 24 hours. The " preparations of these charts, and the reports based on them, have been " under the immediate charge of *Assistant* Cleveland Abbe, A.M., *First* " *Assistant* Robert Craig, acting signal officer and assistant, and *Assistant* " T. B. Maury, A.M., who have been relieved and alternated in the dis- " charge of these and other special duties, at such times as directed under " the instructions of the Chief Signal Officer. The daily series of study- " charts are 12 in number." (Report for 1875, pp. 94, 95.)

" A regular course of study and practice is pursued by officers at this " office, in preparation for these duties. The charting of weather-maps is " practised, until the officer becomes thoroughly familiar with the process, " after which the preparation of deductions from the tri-daily reports is " commenced and made a continuous study.

" The tri-daily synopsis and probabilities have been issued from this " office, in the number explained in previous reports, with unfailing regu- " larity at 10.30 a.m., 6.30 p.m., and 1 a.m. daily; no case of omission or " serious delay having occurred during the year." (Report for 1875, p. 303.)

CANADA.—Twelve (12) persons in all; but of these the superintendent and three others are officers of the Toronto Observatory, of which the Meteorological Office is a recent outgrowth.

Question 12*a*.—*Have any of the staff any other sources of official income?*

AUSTRIA.—One of the adjuncts, Dr. Hann, is professor at the University, and derives from that an augmentation of salary.

HUNGARY.—The officers of the central Station are not allowed to undertake any other service at the same time.

BADEN.—No reply.

BAVARIA.—No reply.

BELGIUM.—No reply.

DENMARK.—The director and one of the assistants are retired officers.

FRANCE.—No reply.

HAMBURG.—No.

HOLLAND.—The director of the Marine Establishment is an officer of the Royal Navy.

ITALY.—See answer to question 12.

PORTUGAL.—The three observers are officers in the Navy, and have the corresponding pay.

PRUSSIA.—No reply.

RUSSIA.—No; except the director, as member of the Academy of Sciences.

SAXONY.—The superintendent is also superintendent of the Observatory, and the Meteorological Department is only a subordinate department. The book-keeper is also employed on the railway. The assistant is occupied with meteorology only.

SWEDEN.—The amanuensis is also a teacher at the Military High School.

NORWAY.—No.

SWITZERLAND.—One of the latter performs certain duties at the Observatory.

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UNITED STATES.—See answer to question 6. What is paid to those on the staff, who do not belong to the Army, is not stated.

CANADA.—The superintendent and the three observatory assistants derive their income chiefly from the observatory.

Question 12*b*.—*What are the usual office hours?*

AUSTRIA.—The usual office hours are from 9 to 2 o'clock; but the staff not being sufficient for the work, the remaining business is performed in the afternoon.

HUNGARY.—According to circumstances, between 6 and 10 hours daily.

BADEN.—No reply.

BAVARIA.—No reply.

BELGIUM.—No reply.

DENMARK.—9 a.m. to 4 p.m.

FRANCE.—No reply.

HAMBURG.—Division I. and II. 9—3 o'clock. Division III. partly 9—4, partly 10—4 and 5½—6½.

HOLLAND.—From 9 till noon a.m., and from 1 to 4 p.m.

ITALY.—See answer to question 12,

PORTUGAL.—From 8 a.m. to 3.30.p.m.

PRUSSIA.—No reply.

RUSSIA.—9 a.m. to 4 p.m., with a little interval about 12 o'clock.

SAXONY.—Every day from 10—1 and from 3—6.

SWEDEN.—10—12 a.m., 6.30—7.30 p.m.

NORWAY.—10 a.m.—3 p.m.

SWITZERLAND.—9—12 a.m., 2—5 p.m.

UNITED STATES.—Rule "for the guidance of the officer, assistant, or other person charged with the preparation of the synopsis and probabilities for publication."

"He will be at the office by 9.30 a.m., and 6.30 p.m., and 11.30 "p.m. of each day." (Report for 1873, p. 365.)

CANADA.—The office hours are strictly from 10 a.m to p.m.; but work requiring part of the staff is going on from 6 a.m. until 1 a.m. of the following day.

Question 12*c*.—*Is residence or any other special advantage enjoyed by the director or any of the staff?*

AUSTRIA.—The director, the three adjuncts, the assistant, the messenger, and the gardener have free lodgings at the Central Institute.

HUNGARY.—The director, the senior observer, and the messenger have an official residence. The second observer receives 20*l*. for lodging money.

BADEN.—No.

BAVARIA.—No reply.

BELGIUM.—No reply.

DENMARK.—The director and custodian have free quarters.

FRANCE.—No reply.

HAMBURG.—No. They receive, however, an addition for residence, according to the Government regulations.

HOLLAND.—Only the director of the observatory.

ITALY.—See answer to Question 12.

PORTUGAL.—The director has the special advantage of 90*l*. a year. The present director gives it over to the extraordinary expenses of the observatory.

PRUSSIA.—No reply.

RUSSIA.—Director, secretary, and office-keeper have an official residence in the observatory.

SAXONY.—The superintendent has an official residence as being superintendent of the observatory. The assistants have no residence provided.

SWEDEN.—No.

NORWAY.—No.

SWITZERLAND.—One of the assistants resides in the observatory (where the Central Institute has hitherto been located).

UNITED STATES.—No reply.

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CANADA.—Residences are not allowed, except to those who are officers of the observatory, and in virtue of their connexion therewith.

Question 13.—*How is the work divided at the Central Office?*

AUSTRIA.—There is no fixed division of the work at the Central Institute, generally the director takes care of the correspondence, of the relations to the several branches of Government and to Foreign Institutes, he is responsible for the funds granted to the Central Institute for the instruments and all materials. One of the adjuncts, aided by the assistant, has to take care of the several registering apparatus and of preparing the publication of the Jahrbuch. Another, of the magnetical instruments and observation, the third of the library, &c. The calculators are employed for reductions, revision of observation, copying, sending of parcels, &c.

HUNGARY.—Director, administration, correspondence with observers and officials, magnetic observations. Observers, daily observations at the Central Office, discussion of the station observations for the year book.

BADEN.—No reply.

BAVARIA.—No reply.

BELGIUM.—No reply.

DENMARK.—The Director has the General Superintendence, correspondence with the authorities at home and abroad, special superintendence of stations in the colonies. The first assistant superintends the instruments and the stations of the kingdom, the second assistant has the telegraphic service and hydrographical researches.*

FRANCE.—No reply.

HAMBURG.—See Instructions for General Marine Observatory.

HOLLAND.—By the Superintendent.

ITALY.—See answer to Question 12.

PORTUGAL.—The Meteorological and magnetic work is done by the observers assisted by the adjuncts.

PRUSSIA.—No reply.

RUSSIA.—Meteorological and magnetic observations in St. Petersburg, land meteorology, sea meteorology, weather reports, and storm warnings, various investigations.

SAXONY.—The book-keeper receives and revises the tables, the assistant prepares the data for the press, and the Superintendent gives the resumé and directs the whole.

SWEDEN.—The work is equally divided, except that the Director takes charge of the correspondence and of the administration. The calculators are only engaged upon the regular observations.

NORWAY.—1st assistant. Telegrams, verifications, computations. 2nd assistants. Reduction and control of barometric observations. 3rd assistant. Reduction of thermometrical and psychrometrical observations. 4th assistant. Reduction of wind and weather observations.

SWITZERLAND.—The chief of the office superintends and critically examines the obseavations and directs the publications. The assistants make the needful calculations, &c.

UNITED STATES.—Full answers to this question will be found in the Chief Signal Officer's Report for 1873.

CANADA.—While each branch is usually performed by one or by two persons permanently detailed for it, it is the practice to make temporary transfers in case of unusual pressure on one branch, and to provide for future cases of absence. It is to be understood that there is much miscellaneous work besides that stated under the following heads, in which every person has occasionally a share:

Examination and tabulation of written reports	2
Weather maps and probabilities	2
Correspondence and records of storms	1
Examination of instruments and visitation	1
Mechanician	1
Disposable	3

* By "hydrographical researches" are implied investigations into currents, sea temperature, &c., on the coast of Denmark.

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Question 14.—*Who appoints the clerks?*

AUSTRIA.—The word "clerks" seem not to apply properly to the adjuncts and assistants of our scientific staff. The adjuncts are appointed by the Minister of Public Instruction. The assistants, by the Director of the Central Institute, the account clerk, messenger, and gardener are appointed by the Lieutenant (Governor) of the province. The calculators, telegraphist, and photographer are appointed by the Director.

HUNGARY.—The Minister of Instruction and Public Worship at the suggestion of the Director. The director is nominated by the Academy of Sciences and by the King.

BADEN.—No reply.

BAVARIA.—No reply.

BELGIUM.—No reply.

DENMARK.—The two assistants are appointed by the Government. The calculator, &c., by the Director.

FRANCE.—No reply.

HAMBURG.—The Imperial Admiralty.

HOLLAND.—The Superintendent.

ITALY.—See answer to Question 12.

PORTUGAL.—The Government.

PRUSSIA.—No reply.

RUSSIA.—The Director of the Central Observatory.

SAXONY.—The Superintendent.

SWEDEN.—The calculators are appointed by the Central Institute. The amanuensis by the Royal Academy of Sciences.

NORWAY.—The 1st assistant by the University, the other three by the Director.

SWITZERLAND.—The Meteorological Commission.

UNITED STATES.—No reply.

CANADA.—The clerks are selected by the superintendent, subject to the approval of the Marine Department.

Question 15.—*What salaries are paid to the clerks and to the superintendent?*

	By Government.	By Central Institute.
AUSTRIA.—Director	£312	
Adjuncts (each)	132 to 165	
Assistant	58	
Accountant clerk	65	
Calculator's (each)	61	
Telegraphist	—	£65
Photographer	—	43
Messenger	45	
Gardener	50	
HUNGARY.—Director		£180
With quinquennial advance of		20
Observer		115
With quinquennial advance of		10
Messenger		35

BADEN.—Superintendent, 86*l.* a year.
The calculator has no fixed salary.

BAVARIA.—No reply.

BELGIUM.—No reply.

DENMARK.—Director, 112*l.* and house,
1st assistant, 112*l.*
2nd do 64*l.*

FRANCE.—No reply.

HAMBURG.—Superintendent of Division, 225*l.*, rising to 255*l.*
Assistants, 120*l.*, rising to 150*l.*

HOLLAND.—The total of salaries must be brought to 833*l.*

ITALY.—See answer to Question 12.

PORTUGAL.—Every adjunct has 80*l.* a year. The superintendent is director.

PRUSSIA.—No reply.

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RUSSIA.—Director 532*l.*, besides the Academy salary.
Assistant, 378*l.*; secretary, 112.
Each physicist, 168*l.*; mechanic, 70*l.*
Each observer, 112*l.*; office keeper, 70*l.*; calculator, 56.

SAXONY.—The superintendent receives a salary of 60*l.*
The book-keeper, about 75*l.*
The assistant, 60*l.*

SWEDEN.—The calculators receive payment according to their work. The amanuensis has 140*l.* a year. There is no superintendent.

NORWAY.—Superintendent, as Professor at the University, 270*l.*
1st assistant, 133*l.*
2nd do. 80*l.*
3rd do. 70*l.*
4th do. 50*l.*

SWITZERLAND.—Superintendent, 160*l.*
Assistants, 60*l.*

UNITED STATES.—The colonel of the Signal Service Corps (Chief Signal Officer,) who has charge of the Meteorological Service, receives 700*l.** The rest of the staff consists of army officers temporarily detached from their regiments.

CANADA.—The chief assistant receives about 300*l.*, and the clerks from about 40*l.* to about 160*l.*
The superintendent receives 200*l.* only, as he derives his income chiefly from another official source.
The rate of payment to assistant is to be regarded as only temporary.

Question 16.—*Who pays these?*

AUSTRIA.—See previous answer.

HUNGARY.—The Royal Hungarian Government. The Budget is annually voted by the Reichstag.

BADEN.—The Grand Ducal Ministry of Commerce.

BAVARIA.—No reply.

BELGIUM.—No reply.

DENMARK.—The Institute pays.

FRANCE.—No reply.

HAMBURG.—The German Empire.

HOLLAND.—The Home Department.

ITALY.—See answer to Question 12.

PORTUGAL.—The Government.

PRUSSIA.—No reply.

RUSSIA.—The Treasury.

SAXONY.—The State.

SWEDEN.—The Central Institute.

NORWAY.—The superintendent. The University pays the Superintendent.
The Institute pays the Assistants.

SWITZERLAND.—The Meteorological Commission, out of the fund allotted to it.

UNITED STATES.—The State.

CANADA.—Salaries are paid from a grant by the Dominion Parliament, amounting at present to $37,000 or about 7,600*l.* sterling.

Question 16*a*.—*Are their appointments permanent, and is there any provision for superannuation?*

AUSTRIA.—The appointment of the Director, of the adjuncts, and of the account clerk are permanent, and there is a provision for superannuation, $\frac{1}{8}$ of the salary, for every five completed years of service beginning with the end of the 10th year, and augmenting till the end of the 40th year.

HUNGARY.—Permanent. The director, observers, and messengers are entitled to pensions.

BADEN.—No reply.

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* Calculated at 5 dollars to the £.

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BAVARIA.—No reply.
BELGIUM.—No reply.
DENMARK.—The organization of the Institute is as yet only provisional.
FRANCE.—No reply.
HAMBURG.—Partly permanent, partly provisional.
HOLLAND.—No, only as long as they are of service.
ITALY.—See answer to Question 12.
PORTUGAL.—Permanent.
PRUSSIA.—No reply.
RUSSIA.—Permanent, with a full pension after 25 years' service.
SAXONY.—No.
SWEDEN.—The two officers are permanent. No pension.
NORWAY.—No.
SWITZERLAND.—There is no provision of this kind. The latter matter rests with the Meteorological Commission.
UNITED STATES.—In his report for 1875, p. 109, the Chief Signal Officer recommends that the non-commissioned officers and privates in charge of Stations should have their pay increased as follows:—

Serjeants to	34	dollars per month.
Corporals	21	"
Privates, 1st class	18	"
" 2nd class	13	"

CANADA.—At present the appointments are not permanent and there is therefore no provision for superannuation.

Question 16*b*.—*Are there any extra allowances, e.g., for additional work or special services?*

AUSTRIA.—There are some extra allowances for the telegraphist, for the calculators, and for the messenger, but none for the scientific staff.
HUNGARY.—Extra allowances are not made.
BADEN.—Only the allowances for travelling expenses paid extra.
BAVARIA.—No reply.
BELGIUM.—No reply.
DENMARK.—No.
FRANCE.—No reply.
HAMBURG.—Yes.
HOLLAND.—No reply.
ITALY.—See answer to Question 12,
PORTUGAL.—Extraordinary work bringing nearly 1*l*. per month to each one.
PRUSSIA.—No reply
RUSSIA.—Yes.
SAXONY.—Yes, for special services.
SWEDEN.—No.
NORWAY.—Only for private business.
SWITZERLAND.—No reply.
UNITED STATES.—No reply.
CANADA.—No extra allowances are made.

Question 17.—*What Publications issue from the Central Office?*

AUSTRIA.—The publications issued by the Central Institute are the following:—

(*a*.) The "Jahrbücher" (Meteorological Annals) of the "Central Anstalt."
1st Series, 8 vols., 1848–56 (published by the Academy of Sciences).
2nd Series, till now 10 vols., 1864 to 1873.
For the years 1857–63 tables of monthly and yearly results have been published in the Proceedings of the Imperial Academy.

(*b*.) The observations made at the Central Institute published monthly by the Academy of Sciences in their Anzeiger.

(*c*.) A lithographed bulletin of Telegraphic Weather Reports, (without charts giving the isobars, &c.)

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HUNGARY.—I. Meteorological Year Books containing monthly and yearly reports, summarized, from all the stations.
II. The daily observations of the central station in printed monthly reports.

BADEN.—Yearly reports, besides every month a summary in the "Carlsruher Zeitung."

BAVARIA.—Every month the observations are published by the Central Station. For many years past these have been worked up into the form of scientific papers.

BELGIUM.—No reply.

DENMARK.—Daily Bulletin of the weather, Bulletin du Nord bi-monthly, monthly resumé of the observations. Annual Report.

FRANCE.—No reply.

HAMBURG.—From Division III.
I. Daily Weather Report.
(*a.*) Lithographed in two sheets.
(*b.*) Telegraphic Reports to newspapers.
(*c.*) To the harbours.
(*d.*) Meteorological observations for Hamburg supplied to a Hamburg newspaper.
II. Monthly summary of weather.
III. Jahrbuch and Annual Report.
IV. Special announcements in the "Annals of Hydrography."
Each of the other divisions issue reports, Wind Charts, Sailing Directions, Division I., and the results of the observations on Magnetic Phenomena, Division II.; Division IV., on chronometers.

HOLLAND.—(*a.*) The publications of the observations in the country.
(*b.*) An international publication extending over as large a part of the world as our means permit.
(*c.*) Tracks for ships, statistics of the ocean.

ITALY.—*Bolletino decadico*, published every 10 days; *Bollettino mensile*, published every month; *Supplements* issued annually.

PORTUGAL.—The Annaes do Observatorio do Infante D. Luiz and Annaes dos Postos Meteorologicos.

PRUSSIA.—No reply.

RUSSIA.—Annals of the Central Physical Observatory.

SAXONY.—1 Monthly Summaries.
2 Results of the Observations of the Meteorological Stations, year I. to VIII.

SWEDEN.—The periodicals are,—
1. Met. Jakttagelser i Sverige.
2. Bull. Mét. du Nord (in connexion with Norway and Denmark).
3.—Väderleks Bulletin.

NORWAY.—A Jahrbuch; a daily bulletin posted up and sent to the papers; Bulletin du Nord in conjunction with Sweden and Denmark; a monthly review in an agricultural periodical.

SWITZERLAND.—The Schweizerische Met. Beobachtungen, which has appeared since 1864.

UNITED STATES.—In the Report for 1875, p. 771, the following list of publications during the year is as follows:—

Farmers' Bulletins	235,023
Bulletins manifold	18,134
Maps	141,223
Weekly Chronicles	28,621
Monthly weather review	171,408
International Bulletins	110,665
Board of Health Reports	290

CANADA.—In the annual report to the Marine Department are printed, for every day in the year, *three* reports from 13 telegraphic stations, the observations being at 7.25 a.m., 4.25 p.m., and 10.50 p.m. (Toronto time), and *one* report daily from 11 stations, observations at 7.25 a.m. In the same report are also printed tables of monthly means, and, for some stations, tables of daily means.

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Weather maps and probabilities are issued daily, but as yet they have not been printed.

Miscellaneous papers are also occasionally issued.

Question 17*a*.—*From what fund is the printing paid?*

AUSTRIA.—The costs of publications are defrayed from the general fund (dotation) granted to the Central Institute.

HUNGARY.—From the budget of the Office, noted as Chancery expenses, 90*l*. a year.

BADEN.—Payment supplied to the Ministry of Commerce.

BAVARIA.—By the Government Department of Finance.

BELGIUM.—No reply.

DENMARK.—The Institute pays for the printing.

FRANCE.—No reply.

HAMBURG.—For 1, (*a*), and 3 the Marine Observatory pays; for 1, (*b*), and (*d*) the newspaper editors; for 2 and 4 partly the Marine Observatory, partly the Admiralty.

Each of the other Division issues reports: Wind charts and sailing directions, Division I.; and the results of observations on magnetic phenomena, Division II.; Division IV., on chronometers.

HOLLAND.—From the Home Department.

ITALY.—The expenses of the publications are charged to the budget of the Ministry of Agriculture and Commerce, Division of Statistics.

PORTUGAL.—From the budget of the Observatory, nearly 165*l*. per annum.

PRUSSIA.—No reply.

RUSSIA.—Out of a special printing fund of the Central Observatory.

SAXONY.—Out of the funds of the year.

SWEDEN.—1. By the Royal Academy of Science.
2. One third of the cost by the Meteorological Central Institute.
3. By a private publisher, who at present receives a subsidy from the State.

NORWAY.—The grant to the Institute.

SWITZERLAND.—Out of the fund supplied by the Government to the Meteorological Commission.

UNITED STATES.—Funds provided by the State.

CANADA.—The annual report is issued at the cost of the fund for printing Parliamentary and Departmental reports; but casual papers and those issued at short intervals are printed at the cost of the Central Office.

Question 17*b*.—*How many copies of your publications are distributed free?*

AUSTRIA.—Copies of the Meteorological Annals are distributed—
(*a*.) To observers at 138 Austrian stations. (138.)
(*b*.) To the Hungarian Meteorological Central Institute. (20.)
(*c*.) To institutes, offices, meteorologists in Austria and in foreign countries. (260)

HUNGARY.—(*a*.) 128 copies to observatories, corporations and private persons.
(*b*.) 98 copies to all the stations of Hungary.
(*c*.) 12 copies to Austrian stations.

238 copies in all.

BADEN.—About 200 copies.

BAVARIA.—20 every month.

BELGIUM.—No reply.

DENMARK—Daily bulletin, 30 copies.
Monthly resumé, 240 copies.
Annual Report, 300 copies.

FRANCE.—No reply.

HAMBURG.—About 125 (this refers only to weather reports).

HOLLAND.—They are nearly all distributed free. Every distinguished meteorologist receives the former publications, every co-operator the latter (Marine section).

ITALY.—More than 400 copies are distributed gratis to the Observatories, to the Institutes of Instruction, and abroad.

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PORTUGAL.—All.
PRUSSIA.—No reply.
RUSSIA.—400.
SAXONY.—150 copies.
SWEDEN.—1. 82 in Sweden and 185 abroad.
2. Are distributed by the Danish Institute.
3. 25 copies.
NORWAY.—About 300 of the Year Book.
SWITZERLAND.—About 180.
UNITED STATES.—No reply.
CANADA.—About 500 copies of the last annual report were given away.

Question 17*c*.—*How many are sold?*

AUSTRIA.—Not more than 10 or 12 copies are sold.
HUNGARY.—Hitherto no copies have been sold.
BADEN.—They are published by Braun, Hofbuchhändler in Carlsruhe.
BAVARIA.—No reply.
BELGIUM.—No reply.
DENMARK.—Daily bulletin, 250 copies.
Monthly resumé, 20 „
Annual report, 15 „
FRANCE.—No reply.
HAMBURG.—About 100.
HOLLAND.—Not a dozen a year.
ITALY.—No reply.
PORTUGAL.—None.
PRUSSIA.—No reply.
RUSSIA.—None.
SAXONY.—About 50 copies.
SWEDEN.—1. Unknown.
2. See Denmark.
3. 150 copies.
NORWAY.—None.
SWITZERLAND.—60.
UNITED STATES.—No reply.
CANADA.—None were sold.

Question 18.—*Are there daily observations published from any stations as well as average (weekly or monthly), and if so from how many stations?*

AUSTRIA.—Daily observations are published from 14 stations (10 in Austria, and 4 in Turkey, Egypt, and Greece), these daily observations from the 1st part of the Jahrbuch. Separate copies are sent to the several institutes about a fortnight after the close of every month. Averages from all stations connected with the Central Institute are published in 2nd part of the Jahrbuch.
HUNGARY.—Owing to lack of funds at present only from the central station and from Fiume, the latter being paid for by the Adria Commission. The Central Office receives telegrams daily from 12 Hungarian, 4 Austrian, and 1 Turkish station (7 a.m.), which are published in several newspapers.
BADEN.—Daily observations from Carlsruhe in two newspapers published here. Monthly reports from all the stations in the "Carlsruher Zeitung."
BAVARIA.—The Munich Observatory.
BELGIUM.—No reply.
DENMARK.—The observations of 16 stations of the 2nd order are published *in extenso;* of the other only the monthly and annual averages.
FRANCE.—No reply.
HAMBURG.—Besides the telegraphic bulletins only Hamburg in the Hamburg "Börsenhalle;" at the end of the year all the stations of the 1st order in the Jahrbuch (only for the observations of weather).
HOLLAND.—From the 10 indicated stations I publish the observations for 3 hours; from the 30 stations of the 4th order only once a day. I have

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copies ready of the hourly observations at Helder, Groningen, Utrecht, Amsterdam, &c.

ITALY.—No reply.

PORTUGAL.—The 9 a.m. observations of this observatory, of the continental stations and Funchal are daily published in the Government Journal and in other newspapers.

PRUSSIA.—No reply.

RUSSIA.—From all stations of the 1st and 2nd order.

SAXONY.—Yes, daily from the Central Station. Monthly and yearly summaries from the stations of the 2nd and 3rd order.

SWEDEN.—From 9 stations observations are published daily in the Bulletin Met. du Nord, and in the Vadeleks Bulletin, and in the newspapers. Monthly in the Stockholm paper "Afton Bladt." The monthly average of temperature at 8 a.m., and the total of rainfall for 17 stations.

NORWAY.—Daily for 12 stations. Averages for about 30 stations (in the Jahrbuch).

SWITZERLAND.—From 15 stations the observations are printed in full; from about 30 others daily averages, &c. From the rest, monthly summaries.

UNITED STATES.—No reply.

CANADA.—For answer, see Question 17.

Question 19.—*Is provision made for the discussion of particular points in reference to storms, weather, public health, agriculture, &c., or in reference to more scientific questions?*

AUSTRIA.—The discussion of particular points in reference to storms, &c. is left as free and voluntary work to the different persons constituting the scientific staff. The Journal of the Austrian Meteorological Society is the usual publication in which questions of this nature are discussed.

HUNGARY.—By several observers phenological observations are made with special reference to agriculture which are published in the Jahrbücher. A comparison of the relation between disease and meteorological conditions is periodically published by the Statistical Bureau of Vienna.

BADEN.—No.

BAVARIA.—The official stations of the 2nd order are specially appointed for agriculture and forest purposes.

BELGIUM.—No reply.

DENMARK.—The study of the great movements of the atmosphere has been prepared by the construction of synoptical charts, embracing the whole of Europe, since the commencement of 1867. The distribution of rain over the country with the different winds is specially studied.

FRANCE.—No reply.

HAMBURGH.—Yes.

HOLLAND.—Certainly.

ITALY.—No reply.

PORTUGAL.—No.

PRUSSIA.—No reply.

RUSSIA.—The director, his assistant, and the physicists are pledged to do such work. The results are published in the *Repertorium für Meteorologie* brought out by the Academy of Sciences.

SAXONY.—No. However the influence of the climate on agriculture and the economy of forests is to be ascertained, this being a matter for the superintendent to decide.

SWEDEN.—The collected material is worked up into scientific papers. Of these have appeared:—(1.) *Edlund:* Contributions to the knowledge of the climate of Sweden. (2.) *Rubenson* on the amount of the rainfall in Sweden, &c. Presented to the Academy, but not yet printed are: (1.) *Rubenson* monthly and yearly averages of temperature. (2.) *The same* on the daily variations of temperature. (3.) *Forssmann* on the high-water observations instituted on the Swedish Coast.

NORWAY.—It is left to the time the director may find for such.

SWITZERLAND.—The discussion of materials has been provided for and is in part commenced.

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UNITED STATES.—In the Report for the year 1875, p. 96, it is stated, that "During this period 1,023 signals have been ordered, counting each "separate display at each port a separate signal, in anticipation of 67 "dangerous *storms*. Of this number 76 per cent. have been afterwards "reported as verified by the occurrence of dangerous winds at the "points where the signals were displayed, or within a radius of 100 "miles from these points."

"The effort has been continued during the year to exhibit as widely "as possible in the *agricultural* districts the results of the daily Office "studies, in the form of printed forecasts, for the benefit of the agri- "cultural population of the United States. The continuance of this "work has seemed to be warranted by the favour with which it has been "received. By an arrangement with the Post Office Department, "6,364 printed farmers' bulletins, on which have appeared the daily "reports of this Office, have been distributed and displayed in frames "daily, at as many different post offices in different cities, villages, and "hamlets in different States. At midnight of each day, the midnight "report of the Office for the ensuing day is telegraphed to 20 centres "of distribution, as follows: These have been carefully selected as "located in the midst of the denser agricultural populations of the "States, and at points where facilities of communication enabled the "surrounding districts to be most rapidly supplied. The telegraphic "report received at a centre of distribution is at once printed by "enlisted men of the Signal Service, on bulletin forms provided for "that purpose, enveloped as rapidly as printed, addressed to each "designated post office within the district to be supplied, and which "can be reached by the swiftest conveyance by the hour of 2 p.m. of "the date, and are then placed in charge of the Post Office Depart- "ment, under an arrangement by which each postmaster receiving the "bulletin has the order of the Postmaster General to display it instantly "in a frame provided by this Office for the purpose, and to report the "fact of its receipt and of its display in writing to the chief signal "officer.

"The average hour at which the bulletins have reached each of the "different post offices, and have been displayed in the frames, has been "11 a.m. It is difficult to estimate the number of people and the "varied interests it has been attempted in this way to benefit."

CANADA.—Weather maps are constructed daily for the whole continent for each of the three telegraph hours, and are studied with a view of advancing a knowledge of the principles of prognostication as well as for prognostication relating to the immediate future.

The importance of discussions regarding health, agriculture, &c. &c., and sundry scientific questions is fully recognised; but as the value of such discussions depends (ceteris paribus) on the correctness of observations, the number and territorial distribution of good stations, and the number of years in which observations are carried on, it has been thought better to employ the strength of the Office in improving the data rather than in drawing premature conclusions from them.

Question 20.—*Have any researches been carried on with a view to the improvement of instruments or methods of reducing observations?*

AUSTRIA.—Attention has been directed, of course, to the improvement of instruments and of the methods of reducing observations. With regard to instruments, the Adjunct Professor Osnaghi has been busy with the construction of new, and the improvement of already existing, instruments. Of the methods of reduction the simplest have been found to answer best.

HUNGARY.—For ascertaining the formulæ of reduction for air pressure and temperature there exists lithographed material extending over 12 years; but the staff for calculating them is wanting. The formulas of reduction drawn out by Jelinek ("Ueber den täglichen Gang der vorzüglichsten Meteor. Elementen") are provisionally in use.

BADEN.—No reply.

BAVARIA.—At the Central Station.

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BELGIUM.—No reply.
DENMARK.—A new anemometer is in course of being tested.
FRANCE.—No reply.
HAMBURG.—Among such researches must especially be mentioned the supply of the stations with instruments last summer; the result was, very special directions given to the mechanicians with reference to each of the instruments; the researches are being carried on, especially as regards the equipment of the stations.
HOLLAND.—Not particularly with a view to the improvement of instruments.
ITALY.—No reply.
PORTUGAL.—Yes, especially as to the best mounting of the psychrometer.
PRUSSIA,—No reply.
RUSSIA.—(See answer to Question 19.)
SAXONY.—Yes; but in general the methods are altered according to the resolutions of the Congress of Vienna.
SWEDEN.—No.
NORWAY.—The locality has hitherto forbidden such investigations.
SWITZERLAND.—Various researches are to be found in the Appendices to the yearly volumes.
UNITED STATES.—"A model rain-gauge, a model anemoscope, and a model "mechanical barometer, all self-registering, and arranged upon plans "not known to have been before used, have been constructed at the "office, and are now undergoing the usual tests." (Report for 1875.)
CANADA.—Attention has been turned to the contrivance and improvement of apparatus, and specially of anemometers.

Question 21.—*What is the cost of the Meteorological Department under all its different heads?* (1.) *For instruments.* (2.) *For stations.* (3.) *For observers.* (4.) *For cost of records.* (5.) *For transmission to Central Office.* (6.) *For verification of observations.* (7.) *For publication of results.* (8.) *For warnings of storms.* (9.) *For abstract physical or scientific results.*

AUSTRIA.—The wants of a Central Meteorological Institute are changing every year, and the more so if the funds granted to it in former years have been low beyond measure, and if the relations of the Institute have been totally altered by the erection of a new building for the observatory, (1870–72) and the erection of many new self-registering instruments. It seems therefore advisable not to communicate the fixed sums granted systematically to the Central Institute (to which supplementary grants have been added) but the funds asked from the Government for the year 1877.

(1.) Instruments, library, &c. - - - -	£280
(2.) Instruments for stations, carriage of instruments, &c. -	58
(3.) Small remunerations to some observers - - -	25
(4.) Records, printing of forms for entering the observations -	17
(5.) For messengers carrying the telegrams to the telegraph office at eight stations - - - - -	20
(6.) Verification for inspections - - - -	50
(7.) Publication of Jahrbuch and lithographed bulletin -	178
(8.) Warnings of storms. There are no warnings in the proper sense in Austria. The Meteorological Telegrams are transmitted free of cost. Forms for telegraphic records, &c., and pay of telegraphist - - -	77
(9.) There is no fund for abstract physical or scientific results. Practically application must be made to the Academy of Sciences or to the Meteorological Society.	
Total -	£705

From the total sum of 705*l.* there have to be subtracted the remuneration given to the photographer and to the telegraphist (43*l.* and 65*l.*) as already mentioned in answers to Question 15. If this is done the total sum will be 597*l.*

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There are still other costs: (*a*), for conservation and repair of the premises, 42*l.*; (*b*), for fuel, 55*l.*; (*c*), for gas in the office, on the stairs, in the corridors &c., for cleaning and keeping up the garden, 83*l.*; total, 180*l.* The total expenses of the Meteorological Institute under all its different heads are therefore:

A. For the staff - - - -	£1,220
B. For the Central Institute and the stations	597
C. For the premises and the garden - -	180
Total -	1,997

HUNGARY.—(1.) (2.) £200 Central Office and stations.
(3.) 100
(4.) (5.) (6.) (7.) are defrayed out of the sum for Chancery expenses. 50 40
(8.)
(9.)

The entire budget, including salaries, rent, &c., 1,300*l.*

BADEN.—Not known.

BAVARIA.—(1.) £186 (2.) 122 expenses of outfit.
(3.) 87 (4.) 19 (5.) — (6.) — (7.) 8 10*s.* yearly maintenance.
(8.)
(9.)

BELGIUM.—There is no office created specially with reference to the study of meteorology. The labours of the Royal Observatory are divided between two distinct services, the astronomical and the meteorological; but the grant which is allowed each year to the Observatory is common to both, and is subdivided as follows:

Staff - - - - - - - -	£742
Material (*i.e.*, printing, purchase of instruments and works, miscellaneous expenses, &c.) - - -	322
	1,064

DENMARK.—The budget of the year 1875 may be divided as follows:

Director, two assistants - - - -	£292
Draughtsman and calculators - - -	120
Instruments and stations - - -	105
Printing of lists, &c. - - - -	96
Library - - - - - -	38
Office custodian - - - -	75
Observers - - - - -	99
Journeys of inspection - - - -	30
	855

FRANCE.—No special budget. The expenses of land observations are defrayed out of the vote for the National Observatory; those of maritime observations out of the Navy vote.

HAMBURG.—Expenses of the Central Station building, repairs, and travelling expenses - - - - - - £650
Expense of telegraphic reports - - - - - 1,500
For instruments, models, books, charts, and publications - 900
Office expenses of the agencies, and for keeping their books - 125

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HOLLAND.—I have not so large a sum at my disposal that strictly defined sums should be allowed under so many heads. Till now we have never paid more for the staff, clerks, and personal assistance in general than - - - - - - - - - £625
And for instruments, publications, different costs - - 583

1,208

However, the director of the Marine section and I have each from other sources about 167*l.* - - - - say 375
Telegrams which are paid by the Government - - - 500

Total, all included - £2,083

ITALY.—No reply.

PORTUGAL.—(1.) £112
(2.) —
(3.) 216
(4.) 15
(5.) —
(6.) —
(7.) 90
(8.) —
(9.) —

PRUSSIA.—For salaries of one councillor and one assistant, including an allowance to the latter for house rent - - - - £372
For all other personal expenses, remunerations to watchers at the different meteorological stations - - - - 825
Remuneration for special services - - - - 15
For repairs of meteorological apparatus, for stationery, printing, bookbinding, and travelling expenses - - - 278

Total - £1,490

It may be observed that besides the special Meteorological Institutions of the remaining German States, the Hydrographic Department and the German Lighthouse Department, both of which are under the control of the Minister of Marine, are connected with the Meteorological Institute. Their respective costs are, for 1876—

For the Hydrographic Department - - £6,922
„ Lighthouse - - - - 6,514

A new observatory is in course of erection at Potsdam.

RUSSIA.—Yearly credit of the Central Observatory at St. Petersburg, for the time being, 6,300*l.* The weather telegrams are quite free and may be estimated at 7,700*l.* a year. The outlay on the other hand for meteorology and earth magnetism may be computed at 5,600*l.* This principally concerns the other stations of the 1st order, Tiflis, Pekin, Barnaul, &c.

SAXONY.—About 750*l.*
(1.) about £100
(2.) „ 30
(3.) „ 250
(4.) „ 75
(5.) } „ 75
(6.) }
(7.) „ 90
(8.) „ —
(9.) „ —

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SWEDEN.—1,098*l.*, viz. :—

	£	s
Salary of director - - -	281	5
,, amanuensis - - -	140	0
,, the observers - - -	371	5
Calculations - - - -	84	5
Servants - - - - -	39	5
Instruments for private stations - -	56	0
Other expenses - - - -	125	0
Total -	£1,098	0

NORWAY.—1,080*l.*

I am not able to class the cost under these heads exactly. The annual grant is 1,080*l.*, of which 480*l.* is for expenditure for instruments, printing, house rent, tours of inspection, &c., and the rest is for salaries to officials and observers. Telegraphy is free.

SWITZERLAND.—About 640*l.* per annum.

(1.) £32
(2.) 40
(3.) 32
(4.) —
(5.) 16
(6.) 280
(7.) 240
(8.) —
(9.) —

UNITED STATES.—The following are the returns of sums expended by the Signal Office during the fiscal year 1874–5 :

For the maintenance of stations already existing and establishment of new stations - - - -	£25,660
For manufacture, purchase, and repair of meteorological instruments and storm signals - - - -	3,260
For publication and distribution of maps, bulletins, &c. -	13,460
For construction of telegraph lines - - -	20,800
For cost of telegrams and postage communication -	39,662
	£*102,842

CANADA.—It is impossible to state in each case the cost of the several heads (1) to (9). For example, the cost of stations, as distinct from salaries of observers, cannot be separated from that of instruments, or from that of records (by which I understand register forms, &c.). Again, the cost of the verification of the observations, and of abstract physical results, is mixed up with that of the salaries at the Central Office, and of the appliances employed there.

As far as it is possible to give them, the details are approximately as follows; but it may be stated that the figures will be greatly modified in future, the cost of the instruments being reduced, and that of visitation and telegraphy being increased :—

1. Instruments - - - - -	£900
2. Visitation of stations - - - -	80
3. Salaries of observers - - - -	1,600
3. Drum agents - - - - -	85
4. Stationery, including forms - - -	260
5. Postage, including transmission of records -	100
6. ?	
7. See 17*a*.	
8. Telegraphy, including *collection* of data, as well as issue of warnings - - - -	2,000
9. ?	

* Calculated at 5 dollars to the £.

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Question 22.—Does your Department deal with both Land and Ocean Meteorology?

AUSTRIA.—The work of the Austrian Central Meteorological Institute is confined to Land Meteorology only; it includes however, magnetical determinations, and more especially observations of the variations of the three magnetic elements, and absolute magnetic determinations, to be made regularly every month at Vienna, and from time to time in the whole Austrian monarchy.

HUNGARY.—Only with Land Meteorology.

BADEN—No.

BAVARIA.—With Land Meteorology only.

BELGIUM.—No reply.

DENMARK.—Until now only with the 1st branch of meteorology. Hydrographic researches have however commenced with the year 1876.

FRANCE.—No reply.

HAMBURG.—Division I. Maritime Meteorology. Division II. Instruments (Literature) (Deviation). III. Coast Meteorology and warnings of storms. IV. Institute for the verification of chronometers.

HOLLAND.—No reply.

ITALY.—No reply.

PORTUGAL.—Yes.

PRUSSIA.—No reply.

RUSSIA.—Yes, but only starting from this year.

SAXONY.—No.

SWEDEN.—Yes, at present; but it is decided to erect a separate Nautical Meteorological Bureau.

NORWAY.—The dealing with Ocean Meteorology is very little. Some observations of temperature of the sea have been discussed. (In future years I intend to propose a special building for the Institute; an observatory of the first order (far from the town); a larger staff of clerks; a division for Ocean Meteorology; an extension of the storm warning system.)

SWITZERLAND.—The latter naturally has nothing to do with us.

UNITED STATES.—No reply.

CANADA.—Nothing has been done with reference to Ocean Meteorology, but it is probable that ships' logs will be collected to aid in the study of storms.

APPENDIX VI.

REPORT of the THIRD COMMITTEE.

First Meeting, 15th April, at 11h. a.m.

Present:—MM. MASCART (President), CANTONI, DE BRITO-CAPELLO, HOUZEAU, MENDELEEF, MOHN, PALMIÈRI, SCHENZL, SNELLEN, WILD, and VON BEZOLD (Secretary).

At the request of the President, Mr. Scott (Secretary to the Congress) submitted a list of the printed reports, &c. on the questions which had been referred to the Committee, viz., Nos. 12 and 16–25, and stated that the question of seismometry had also been referred to it.

The President opened the discussion upon question 10 of the Programme (Comparison of Standard Instruments).

M. Wild spoke upon the comparison of barometers, and gave a resumé of the ideas contained in his report.*

M. Cantoni thought it very desirable that barometers from three stations of Italy, for example, Rome, Naples, and Palermo, should be compared as proposed by M. Wild. In this sense Italy might take part in the realization of the scheme.

MM. Mendeleef, Houzeau, Mohn, and de Brito Capello, made some remarks upon this subject.

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* Rapports sur les questions du Programme, p. 37.

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The resolution given at p. 12 was put to the vote and adopted.

The President opened the discussion upon Question 16 (the Determination of the fixed points of Thermometers).

MM. Cantoni, Wild, Snellen, and Mendeleef took part in the discussion.

The resolution given at p. 12 was put to the vote and adopted.

The discussion on questions 17 and 18 was adjourned.

The President opened the discussion upon Question 19 (Radiation).

MM. Cantoni, Palmieri, and Wild took part in the discussion.

The Committee adopted the resolution given at p. 13.

The discussion on questions 20 and 21 was adjourned,

The President opened the discussion upon question 22 (Rain Gauges).

MM. Mohn, Cantoni, v. Bezold, Palmieri, Snellen, and Zenger spoke upon this subject.

The Committee adopted the resolution given at p. 13.

The discussion on question 23 was adjourned.

The discussion was opened upon question 24 (Ozone).

MM. Cantoni and Palmieri made some remarks, and described the experiments which had been made in Italy upon this subject.*

M. Zenger described a new method which he had employed, based upon the use of hydriodic acid, contained in an apparatus with Liebig's bottles, through which the air was made to pass by means of an aspirator.

MM. Cantoni and Palmieri spoke of the great difficulties connected with an exact determination of ozone.

The resolution given at p. 15 was adopted,

The next meeting was fixed for Wednesday, 2h. p.m.

E. Mascart, President.
v. Bezold, Secretary.

Second Meeting, 16th April, at 2h. p.m.

Present :—MM. Mascart (President), Cantoni, de Brito-Capello, Houzeau, Mendeleef, Mohn, Palmieri, Schenzl, Snellen, Wild, and von Bezold (Secretary).

With reference to the protocols of the first meeting, the President communicated a letter from M. Marié-Davy to M. Buys Ballot, relative to M. Violle's report on radiation. This letter will be printed as a report to the Congress.†

The protocols were confirmed.

The President opened the discussion upon question 17 (Exposure of Thermometers).

M. de Brito-Capello remarked that he had presented a report upou this subject,‡ and that there was another by M. Wild.§

M. Cantoni proposed that the discussion of this question should be taken conjointly with that of question 20 (Humidity of the Air).‖

M. Wild added some remarks to his report on thermometer-screens.

M. Mohn expressed his satisfaction at finding that M. Wild did not recommend absolutely one definite form of screen, because it was often necessary to take the convenience of observers into account.

M. Wild was quite of the same opinion, and he insisted especially upon the bad effect of the wooden screens of large dimensions which retard the action of thermometers, a disadvantage which the small metal screens did not present.

M. Cantoni added that he had obtained good results with wooden screens when they were of very small size.

M. Houzeau communicated the general result of the comparisons which had been recently made at the Royal Observatory of Brussels with three different thermometers. The first was set up in the garden of the Observatory, placed in a wooden louvred screen of tolerably large size, and protected by

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* Rapports sur les questions du Programme, p. 83.
† Ibidem, p. 277.
‡ Ibidem, p. 267.
§ Ibidem, p. 48.
‖ Ibidem, p. 119.

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the building from the direct action of the sun. The second was placed in the common centre of two hollow metal spheres, each composed of alternative bands and spaces, the bands of one sphere corresponding to the spaces of the other. Lastly, the third thermometer was a sling-thermometer (thermomètre-fronde), used in the open air, in the shade. The result of these comparisons has shown that these three thermometers often did not differ by more than a tenth of degree. This figure, 0°·1, will nearly measure the ordinary difference of these instruments.

M. Tacchini recommended the Committee not to take a definite decision on the form of screens for protecting thermometers; he spoke of the experiments which he had made at Palermo, and stated that wooden screens, whose dimensions were limited even to a metre, ought to be suppressed. He explained the form adopted, viz., "Il Balcone meteorico di Palermo," and which he had proposed for use at other stations; at the same time he acknowledged the very interesting communications of M. Wild.

The Committee adopted the resolution given at p. 12.

The discussion of question 18 of the Programme (Earth Temperature) was opened, and after some observations the resolution given at p. 13 was adopted.

The President opened the discussion upon question 20 (Humidity of the Air).

M. Cantoni read a report upon this subject.*

M. Wild explained some experiments which he had made upon this subject, and he thought it was desirable to add an aspirator, at least for the wet-bulb thermometer.

M. Cantoni made some remarks on the difficulties presented in determining the humidity of the air by means of the dry and wet bulb thermometers when the temperature is very near or below the freezing point.

M. von Bezold remarks that these difficulties were well known to him, and that they occur very frequently in colder climates. He proposed that, if possible, the addition of a hair hygrometer, for instance, that of Kappe, of Zurich, should be recommended.

M. Wild stated that, in Russia, hair-hygrometers were everywhere used by the side of the dry and wet bulb thermometers.

M. Snellen made the following communication upon this point: that while he liked the improvement introduced by M. Alluard in the manner of observing the dew-point when Regnault's condensation method is employed for determining the humidity of the air, he nevertheless thought that the same result might be arrived at in the following way: Place behind the vessel containing the ether, by the evaporation of which condensation is attained, a piece of dull blackened paper or other screen, at such a distance that the free circulation of the air shall be in no wise impeded. Then when the silver vessel is examined by means of a magnifying glass, the reflected image of the screen is seen on it, and quite close to it the screen itself; this allows of the accurate determination of the moment of condensation, in this manner; the separation between the vessel and the screen absolutely cannot be seen, at least as long as the surface of the vessel is well polished and no dew is deposited; but at the moment this latter case takes place the separation is immediately seen, the vessel taking a whitish glimmer, while the screen retains its first aspect.

The Committee adopted the resolution given at p. 13.

The meeting closed at 4h. p.m.

E. MASCART, President.
v. BEZOLD, Secretary.

Third Meeting, 17th April, 2h. p.m.

Present :—MM. MASCART (President), DE BRITO-CAPELLO, HOUZEAU, MENDELEEF, MOHN, PALMIÈRA, SHENZL, SNELLEN, WILD, and VON BEZOLD (Secretary).

The President opened the discussion on question 21 (Evaporation).

M. Cantoni made the following remarks:— The numerous experiments made in Italy by MM. Tacchini, Ragona, Frisiani, and myself, in recent

* Rapports sur les questions du Programme, p. 119.

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years, and of which I have given a resumè of the results in a notice published with the Supplement to *Meteorologia Italiana*,* all tend to confirm the following principle :—

" We cannot have comparable atmometers unless all conditions of form are well established as to dimensions, construction, and exposure of the apparatus ; and it is especially necessary that they should be of small size."

After a short discussion, in which MM. Pittei, Wild, Denza, and Cantoni took part, the resolution given at p. 13 was adopted.

The Committee then discussed question 23 (Anemometers).

M. Wild gave an account of M. Dohrandt's investigations upon this subject.†

M. Mohn drew attention to the anemometer of M. Hagemann, of Copenhagen, which appeared to give very good results, at least when the velocity of the wind exceeded a certain rate.

M. Wild stated that he had also made some experiments with this anemometer, but they were not sufficient to enable him to give a definite opinion.

M. Snellen recommended the adoption of M. Spangenberg's method.

M. de Brito-Capello read a report upon this subject.

M. Plantamour regretted that the vertical component of the wind was not sufficiently observed. He was of opinion that this determination would be of the greatest interest, because it would enable us to ascertain the inclination of the wind.

M. Wild stated that he had made various experiments in this direction with a wind vane on a horizontal axis, which had given satisfactory results.

M. Tacchini proposed the employment of a normal standard anemometer.

M. Weihrauch was of opinion that the construction of such an instrument was impossible, on account of the inevitable changes of friction.

M. Snellen was of the same opinion.

M. Houzeau requested that this question might be referred to the International Committee, who would undertake this comparison when it judged it opportune.

M. Wild recommended the transmission by post of one of the anemometers of Schulz of Dorpat, and that it should always be compared before and after a voyage with a normal instrument placed at a certain station, for instance, at St. Petersburg.

The Committee adopted the resolution given at p. 14.

The Committee proceeded to discuss question 25 (Atmospheric Electricity).

M. Mascart gave the Presidency to M. Cantoni.

M. Palmieri explained his views upon this subject, and gave a resumè of the works he had published thereupon.‡

M. Mascart did not share the opinion of M. Palmieri with respect to the continuity of observations, and he insisted upon the following points :

1°. It is necessary to make continuous observations on the phenomenon, because atmospheric electricity changes so very quickly.

2°. It is necessary to make sure always that the insulation is perfect.

3°. The continuous records should be elected by intermittent observations.

4°. It is necessary that the indications of the electrometer should be proportional to the intensity of the phenomenon observed, or at least that each electrometer should be furnished with a table of graduation.

M. Denza reported the experiments made with M. Palmieri's instruments at different places in Italy, and thought that those instruments might everywhere furnish satisfactory results.

After some remarks by MM. Mascart, Palmieri, Cantoni, Wild, &c., the Committee adopted the resolution given at p. 15.

The meeting closed at 4h. p.m.

E. Mascart, President.
v. Bezold, Secretary.

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* Rapports sur les questions du Programme, p. 123.
† Ibidem, p. 40.
‡ Ibidem, p. 261.

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Fourth Meeting, 18th April, at 11h. a.m.

Present:—MM. MASCART (President), DE BRITO-CAPELLO, HOUZEAU, MOHN, MENDELEEF, WILD, and v. BEZOLD (Secretary).

The protocols of the last meeting were confirmed.

The President announced that he had received the following letter from Mr. Buchan on the exposure of thermometers:—

"Scottish Meteorological Society, Edinburgh,
April 14th, 1879.

"MY DEAR SIR,

"I GREATLY regret that, owing to the effects of my accident in September, I have not been able to submit a report on question 17 to the Congress at Rome, as I hoped I should have been able to do in December, when requested to do so by the Permanent Committee.

"Even yet I could not undertake the preparation of such a report on account of the large and difficult question raised by the phrase 'destined to give the temperature of the air.'

"If the problem be a practicable one to devise some instrumental arrangements for the observation of the true temperature of the air, we are so far from an approximate solution of it as practically to shut us up to the adoption of a method of observation which will secure *uniformity*. Further we cannot meantime go.

"Some time ago Mr. Stevenson published a paper on this point which, as it meets my views, I take the liberty of subjoining.*

"I continue to make steady and satisfactory progress.

"Yours faithfully,
ALEXANDER BUCHAN.

"R. H. Scott, Esq.,
"Secretary, Permanent Committee."

M. Zenger exhibited some photographs of the sky in the vicinity of the sun. At the request of one of the members, M. Zenger promised to give a note, which should be printed among the reports to the Congress.†

M. Mascart remarked that the circles shown by the photographs of M. Zenger appeared to be often the reproduction of invisible coronæ.

M. v. Bezold was of the same opinion, and he thought that it was desirable to determine the angular diameter of the circles.

M. Palmièri proposed to repeat the experiments of M. Zenger.

The President communicated to the Committee a work by M. de Rossi (La Meteorologia Endogena, Milan, 1879).

M. de Rossi gave a short resumé of his work, which is printed among the reports.‡

After a short discussion, in which MM. de Rossi, Palmieri, Cantoni, and Mascart took part, the Committee adopted the resolution given at p. 15.

The meeting closed at 1h. p.m.

E. MASCART, President.
v. BEZOLD, Secretary.

APPENDIX VII.

REPORT of the FIRST COMMITTEE.

A. The Committee took points 8, 12, and 13 into consideration, and first discussed the question how, in the interval between this and the next Congress, the furtherance of common work in meteorology could be provided for. Two ways leading to this end were discussed: the establishment of a permanent international central institute, and the appointment of a committee, to hold office until the next Congress, and which should settle the necessary business by regular correspondence and, as often as requisite, by special conferences.

* "Nature," Vol. XV., p. 556, April 26, 1877.
† This note has never been received.
‡ Rapports sur les questions du Programme, p. 257.

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The latter method appeared at the first glance as the most tedious. It must, however, be affirmed that it is not possible at present to create a permanent Central Institute, and, on the other hand, the experience gained between the time of the Vienna and the present Congress, has shown that a Committee whose members are spread even over the whole of Europe are able to co-operate satisfactorily in carrying out the decisions of the Congress, and in preparing and even executing meteorological investigations of a general nature.

The Committee thought, therefore, that they would promote the object best in proposing for the immediate future a similar organisation. By the help of the Committee, also, the discussion and publication of such works as require international support will be facilitated. The Committee, after deliberation, have adopted the resolutions which are now submitted for the approval of the Congress (*vide* p. 16).

For the execution of its functions the Committee will need certain funds, for which purpose the formation of an international fund was proposed in section 8 of the Programme; it was proposed that the countries taking part in the Congress should be called upon to pay a fixed contribution to this fund. Many members, however, declared that they had not received the sanction of their Governments to such an obligation, and as it had not been difficult hitherto to obtain the requisite funds by mutual agreement in each special case, it was preferred to refrain from making any resolution thereupon, and to leave it to the Committee to provide as hitherto for the reimbursement of their expenses in a similar way.—Resolution D., p. 17.

B. The Committee is of opinion that a new Congress should be convened after a maximum interval of five years.—Resolution B., p. 17.

C. With regard to the further proposals made in points 12 and 13, the Committee proposes the Resolutions A. and C. given at pp. 16 and 17 for the decision of the Congress:

(Signed) BRUHNS,
Secretary.

APPENDIX VIII.

REPORT of the SECOND COMMITTEE.

The second Committee had the following questions to consider:

Questions 4 and 5 of the Programme of the Permanent Committee with the proposals of MM. Hildebrandsson, de Brito-Capello, and Weihrauch.

A communication from M. Wojeikoff.*

The proposal of M. Pittei.†

Question 9 of the Programme of the Committee.

Question 15 of the Programme with the proposal of M. Hellmann.

Qusetion 4.—With respect to the Report of M. Buys Ballot on the reduction of means of observations employed in the different countries to true means, the Committee proposes the resolution given at p. 20.

Question 5.—After a thorough discussion, the result of which was that the number of international stations indicated in the Utrecht report should be considered as a minimum, and in which the great difficulties which are opposed to the enlargement of the form were brought forward, and in taking into account also the proposals of MM. Hildebrandsson, de Brito-Capello, Mühry, &c., the proposal of the Committee was accepted in the form suggested by it (*vide* p. 20).

On the proposals of MM. Hildebrandsson and de Brito-Capello respecting the regular publication of observations of the direction of the upper clouds, and seeing their great importance, which has also been set forth by Captain Hoffmeyer, the Committee, considering the form adopted by M. Wild as the best, makes the proposal given at p. 22.

On the proposal of M. Weihrauch as to the great importance of having the data of the mean force of wind, the Committee, after having discussed this

* Rapports sur les questions du Programme, p. 253.
† Ibidem, p. 165.

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matter by itself, as well as the form to be chosen for the publication of these data, adopted M. Weihrauch's proposal in the form given at pp. 20–21.

M. Wojeikoff, of St. Petersburg, has sent to MM. Hann and Hoffmeyer charts with isobars for the whole globe, together with explanatory text. After an exchange of ideas upon this interesting subject, and in accordance with the expressed desire of M. Wojeikoff. The Committee presents to the Congress the charts which M. Wojeikoff has sent representing the mean annual distribution of atmospheric pressure, and which are intended to form a part of a more extended work on the climate of the globe.

On the proposal of M. Pittei to publish an international dictionary of meteorology, and after a discussion as to the contents of this dictionary, the resolution given at p. 22 was adopted.

Question 9.—M. Hellmann proposes to add thereto a catalogue of books and papers on meteorological subjects.

After a long discussion, in which all the members of the Committee took part, communicating all the publications of this kind which are already at our disposal, the resolution given at p. 21 was adopted.

Question 15.—As to the establishment of rules and formulæ for reducing barometric readings to the sea level in a uniform manner.

M. Bruhns gave a brief summary of the results of the report which he had drawn up upon this question.*

M. Bruhns and other members then stated the difficulty met with in determining the mean temperature of the column of air comprised between the sea level and a station under consideration, which temperature is necessary for the reduction of the barometric reading to the sea level.

Upon this point M. Plantamour insisted that the barometric formulæ were not applicable when it was a question of isolated observations, the condition of the equilibrium of the atmosphere being realised only by means of a large number of observations.

The Committee, in conformity with the views of MM. Bruhns and Hellmann, adopted the resolution given at p. 22.

(Signed) Blaserna, President.
Hann, Secretary.

APPENDIX IX.

Report of the Fourth Committee.

First Meeting, 15th April, at 4h. p.m., under the Presidency of M. Neumayer.

The questions submitted to the 4th Committee were Nos. 6, 27, 28, 29, 34, and 35.

The President proposed the nomination of three sub-committees, but after some observations by MM. Mascart, Lorenz, and Scott, it was proposed by Captain Hoffmeyer that the whole of the questions should be treated by all the members of the Committee. This proposal was put to the vote and adopted.

The Committee then proceeded to discuss the different questions,

Question 6.—M. Pittei thought that the International Code, which was very useful for the exchange of telegrams between different countries, should be modified for national telegrams, as was in fact the case in Italy.

M. Mascart said that the discussion on question 6 might perhaps be referred more usefully to a future Congress, after preliminary experience, for at present in France, for instance, (and this country was perhaps not the only one,) the central office was occupied in putting the International Code into practice, in the form which was adopted at Utrecht, and it would be impossible for him, at least at present, to introduce any change.

M. Lorenz proposed, on the contrary, to discuss the question of improving the system of meteorological telegrams, adding, that it was for each Govern-

* Rapports sur les questions du Programme, p. 191.

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ment to judge of the desirability of introducing the changes proposed by the Congress.

M. Pujazon recommended the Committee to adopt the following proposal:—"The Committee recommends for general adoption the telegraphic code proposed at Utrecht."

After some remarks by MM. Pittei, Pujazon, Bruhns, and by Mr. Scott, who drew attention to the improvements proposed by MM. Hann and Rikatcheff, Captain Hoffmeyer observed that the different reports had only just been distributed, and the members had not had time to study them, and further, that these reports touched upon all the questions which were to be discussed. He therefore proposed as a principle that all the questions should be discussed twice, and Mr. Scott especially requested the adjournment of question 6.

Captain Hoffmeyer's proposal was adopted by six votes to five, the other members abstaining from voting. Mr. Scott's proposal was unanimously adopted.

Questions 27, 28, and 29 were likewise adjourned, as certain reports had only just been distributed, and also because of the absence of General A. J. Myer, who was expected.

Question 34.—Captain Hoffmeyer gave certain particulars relative to the construction of his synoptic charts, and said that the simultaneous observations were, in his opinion, still too few, and too unequally distributed for the purpose of undertaking synoptic charts; he would, further, try to introduce into his charts all possible improvements, and he finally requested that the question of synoptic charts, and of simultaneous observations, should not be mixed up, but treated separately.

Mr. Scott gave some information about the synchronous charts which had been constructed in England, about those of General Myer, and more particularly about those of Mr. Meldrum for the Indian Ocean.

MM. Mascart, Pujazon, and de Brito-Capello stated that in their countries simultaneous observations were, or were about to be, put into practice.

A vote was taken as to whether questions 29 and 34 should be separately discussed; and it was decided that they might be discussed together as circumstances required.

The Committee voted the adjournment of the discussion.

The meeting closed at 6h. p.m.

G. Neumayer.
Brault.
R. Müller.

Protocol of the Second Meeting, 17th April, at 4h. 30m. p.m.

President: M. Neumayer.

The protocols of the meeting of the 15th April were read and confirmed.

The President opened the discussion upon question 6 (the Telegraphic Code), and called upon Mr. Scott, who stated that he could not accept the conclusions of M. Hann's report. He was of opinion that at present nothing should be changed in the code proposed at Utrecht, and he thought that it would be preferable to leave to a future Congress the study of the improvements that might be introduced into it.

Captain Hoffmeyer supported this opinion, but he thought with M. Rikatcheff, that it would be very desirable that meteorological telegrams should contain also barometric and thermometric changes, &c.

M. Mascart thought that whatever modifications might be introduced, it would be more prudent at present to keep to the system actually in use.

Mr. Scott remarked that the meteorological reports would undergo a very considerable delay if the data desired by M. Rikatcheff were introduced.

M. Wild proposed the following resolution:—"The Congress is of opinion that "there is no occasion to change the present form of meteorological telegrams, "but it recommends to the directors of central institutions to take into consideration M. Rikatcheff's proposal relative to the study of barometric and "thermometric changes, &c."

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After some observations by MM., Pujazon, Pittei, Lorenz, and Hoffmeyer, M. Pujazon proposed the resolution given at p. 23.

Mr. Scott requested that the International Code should not be changed.

M. Pittei suggested an amendment to the proposal of M. Wild; instead of "but it recommends," to put "...and recommends to the Permanent Committee to study the modifications that it would be useful to introduce into it."

The President put the various proposals to the vote, and that of M. Pujazon was adopted.

Question 28 (Maritime Meteorology.)—Mr. Scott proposed the resolution given at p. 23.

Captain Hoffmeyer supported this resolution, which, after some remarks by the President and Mr. Scott, was adopted unanimously.

Mr. Scott proposed that the members interested in Agricultural Meteorology should meet privately to deliberate upon question 35.

The Committee decided that this meeting should take place in the evening at 8 o'clock.

The meeting closed at 6 o'clock.

G. NEUMAYER.
BRAULT.
R. MÜLLER.

Protocol of the Third Meeting, on the 19th April.

The meeting opened at 3h. 30m. p.m. The protocols of the meeting of the 17th April were read and confirmed.

The President, in the first place, opened the discussion upon question 34 (Synoptic Charts), Captain Hoffmeyer having presented to him the following proposal upon this question:—

"The Congress is of opinion that a Monthly Synoptic Review of the "Weather of Europe, analogous to that published by the Chief Signal Office "of the United States for North America, would contribute greatly to the "advance of Meteorological enquiry, and for that reason it recommends such "a publication, on the understanding,—

"(1.) That such a publication could not be complete nor even possible "without the active co-operation of all the central institutes of "Europe, and the contribution of all their contingents of continental "and maritime observations.

"(2.) That, on the other hand, the necessary unity of method in the work "requires that all the materials should be collected and discussed "at the same place, or at least by institutions who have made an "agreement to work together on an uniform plan.

"(3.) That the Meteorological Institute of Copenhagen and the Deutsche "Seewarte of Hamburg have already published works of this nature "for several years, to wit, the Copenhagen Institute, the Daily "Synoptic Charts of Europe, and the Atlantic Ocean, and the "Deutsche Seewarte, a monthly resumé of the weather of Central "Europe."

"The Congress accepts the proposal made by these two institutions, to "undertake the publication of a monthly synoptic review of the weather and "invites the other central institutions of Europe to take steps for obtaining a "number of subscriptions proportionate to their respective positions, in order "to cover the material expenses of this publication."

M. Neumayer requested M. Wild to be good enough to take the chair during the discussion of this question, in which he wished to take part.

Captain Hoffmeyer offered some explanations upon different points of his proposal.

M. Neumayer stated that he was completely in accordance with Captain Hoffmeyer, and that he hoped that with time, and the improvements which he would introduce into this publication, the synoptic review would become more and more important.

M. Pujazon thought that the proposal under discussion, being within the province of the Permanent Committee, should not be dealt with by the Congress; he thought, however, the proposed publication was very commendable.

Mr. Scott stated that he had heard with pleasure the proposal made by MM. Hoffmeyer and Neumayer, and would do all that depended on him to assist in carrying it out.

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M. Mascart declared that it was impossible for him to commit himself to an annual subscription in favour of this publication.

The proposal was put to the vote and adopted by the majority.

Question 29. (Simultaneous observations.) (M. Neumayer in the chair.)

Mr. Scott thought that the Congress might declare that it took great interest in simultaneous observations.

M. Hoffmeyer thought that simultaneous observations had not hitherto contributed very much to the advancement of meteorology; the cause of this was to be looked for in their almost total absence in arctic regions, and in the fact that they gave the conditions of the weather at a very late hour of the day in Europe. To enable them to be used in synoptic charts they must be developed in the sense of giving three equidistant observations in the 24 hours, and to be nearer to each other in northern countries.

M. Brault thought that the synoptic charts hitherto constructed, with observations taken at local times, were insufficient, and that it was time to introduce more precise charts into the science. It was from this point of view that simultaneous observations were of great importance. Synoptic charts, such as now drawn, were false in principle; they combined, by curves, observations made at intervals of one to four hours, and thus gave only a somewhat rough approximation of the state of the weather, a condition which simultaneous charts would give with precision. He hoped therefore that very soon simultaneous charts would replace synoptic charts, to the great profit of the science.

MM. Scott and Mascart made the proposal printed at p. 24, which was adopted unanimously:—

Question 35 (Agricultural and Forest Meteorology).—The President said that he was of opinion that question 35 was so important that the discussion of it could not be finished by this Committee, and he thought it would be necessary to convoke a special conference for it, similar to that of 1874, for maritime meteorology.

M. Lorenz, after having given some information as to the actual condition of Agricultural Meteorology, proposed to the Committee to submit the following resolution to the Congress:—

"In order to contribute to the progress of Agricultural and Forest Meteor-
" ology, the Congress recommends as a programme for study,—
" 1. The influence of the meteorological elements upon vegetation.
" 2. The inverse influence of vegetation upon the meteorological elements.
" 3. Agricultural warnings."

After several members of the Committee had taken part in the discussion upon this subject, the Committee unanimously accepted the resolution proposed.

M. Denza submitted the following resolution to the Committee:—

"The Congress, in view of the development that agricultural weather fore-
" casts have taken in many countries, and of the results obtained, supports the
" efforts of those who are occupied with these applications of meteorology, and
" encourages all those who propose to introduce this same service into countries
" where it has not yet been adopted, and where it is demanded by the public,
" provided that this be done with every precaution and without compromising
" the science."

MM. Tacchini, Wild, and Scott made some remarks upon this question. Owing to the lateness of the hour, the President proposed that the discussion should be adjourned to the next meeting, which was fixed for Monday, 21st April, at 2h. p.m.

G. Neumayer.
Brault.
R. Müller.

Protocols of the Fourth Meeting on 21st April.

The President opened the meeting at 2h. p.m.

The protocols of the meeting of the 19th April not yet being finished, the President was of opinion that the meeting of this day should be considered as a continuation of that of the 19th April, and he proposed the discussion of question 35.

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Before the discussion was commenced Professor Smith made some remarks and proposals, seconded by M. Mascart, relating to question 34 (Synoptic Charts).

The President declared that it seemed to him impossible to be able to finish a fresh discussion to-day upon this question, and therefore he proposed to hold another meeting to-morrow morning.

This proposal was accepted.

M. Lorenz continued the reading of the details of his proposal (Question 35).

Mr. Scott requested that a phrase might be inserted in it, drawing attention the work of General Myer in relation to agricultural meteorology.

M. Pietti requested that the details of the proposal should be omitted. He shared the opinion expressed by the President at last meeting, and wished also that the question should be referred to a special conference.

Mr. Scott supported this idea, and requested, on the part of M. Hann, that the term "agricultural and forest meteorology" might be used.

M. Lorenz did not consider the addition of the word "forest" necessary, as it, in his opinion, was included in the general denomination of "agricultural meteorology."

M. Mascart, on the contrary, insisted upon this addition. After some remarks by M. Pittei, M. Wild, in accord with that gentleman, made the following proposal:—

"After having heard and discussed the reports of M. Lorenz upon this "subject, the Committee proposed to the Congress the adoption of the "following resolution (*vide* p. 24)."

The proposal was put to the vote and adopted unanimously.

After the President had remarked upon the great importance of the proposal, which appeared to be the sole means of solving, to the best advantage, the question of the application of meteorology to agriculture and the cultivation of forests, the meeting closed at 3h. 30m. p.m.

G. NEUMAYER.
BRAULT.
R. MÜLLER.

Protocol of the Fifth Meeting, on 22nd April.

The President opened the meeting at 8h. 45m. p.m.

The Secretary read the protocols of the meeting of the 19th and 21st April.

After having heard Professor Smith's remarks upon the protocol of the meeting of the 19th, the Committee adopted the protocols, with the reservation of the following resolution proposed by M. Mascart, in accord with MM. Hoffmeyer and Neumayer, and which should be substituted for that previously adopted (*vide* p. 24).

This resolution was unanimously adopted.

The President asked whether M. Denza desired the discussion of his proposal of Saturday last (p. 78), upon which the latter did not insist.

The President declared that the Secretary had no time to make a detailed report upon the labours of the Committee. He proposed merely to give the different proposals and resolutions adopted by the Committee and to submit them in the general meeting of the Congress.

The Committee adopted this proposal and the meeting rose at 9h. 15m. a.m.

G. NEUMAYER.
R. MÜLLER.

The protocol of the meeting of the 22nd April was read and confirmed by—

MM. BRUHNS.	MM. MASCART.
CAPELLO.	MÜLLER.
DENZA.	PITTEI.
HOFFMEYER.	SCOTT.
LORENZ.	WILD.
	NEUMAYER.

(The other members of the Committee being absent.)

R. MÜLLER.

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APPENDIX X.

Report of the Fifth Committee.

First Meeting, Wednesday, 16th April, at 9h. a.m.

The meeting was opened by M. Denza, President.

Mr. Scott laid the following communications upon the table :—

1°. A letter addressed by himself to the French Aeronautical Society on the importance of meteorological observations in captive balloons; and also the reply of the society, in which the latter stated that Mr. Scott's proposal had been entered among its agenda (Question 30).

2°. A letter from M. Parkinson, Samoan Isles, to M. Wild. (Question 32.)

3°. A letter from M. Hann to Mr. Scott on the importance of the observations on the motions and changes of existing glaciers. (Question 30.)

4°. A letter from Mr. Nichols and two letters from Mr. Freshfield, on the same subject. These gentlemen lead us to hope for the co-operation of the members of the London Alpine Club in the above-named researches upon glaciers.

5°. A printed letter from Mr. John Ball on the same subject.

6°. Letter from the Central Direction of the Austro-German Alpine Club to Mr. Scott, requesting instructions as to the manner of observing the motions and changes of glaciers.

M. Hann presented :—

1°. A letter from the Direction of the Austro-German Alpine Club upon glaciers.

2°. A work by M. Fritz upon the periodical changes in length of glaciers.

M. Hellmann communicated a letter from Mr. Knipping, of Tokio (Japan), containing information about several meteorological stations in Japan.

Mr. Scott presented to the Committee a copy of "Contributions to our Knowledge of the Meteorology of the Arctic Regions," published by the Meteorological Council of London, and stated that he hoped that this publication would be continued.

The Committee thanked Mr. Scott for this present, and requested him to convey its thanks to the Meteorological Council for this important work, and also expressed the hope that it would be continued.

The President announced the opening of the discussion upon the questions of the Programme entrusted to it by the Congress.

The Committee first decided to treat the two questions, 11 and 32, together, as referring to subjects differing very little from each other, viz. :

Question 11.—"The Committee draw attention to the importance of establishing distant stations and supplying them with the necessary instruments."

Question 32.—"In what manner shall we proceed to establish meteorological stations in distant countries where observations have not hitherto been made?"

Upon this latter question M. Mohn has published a scheme* and MM. Parkinson and Wild have made proposals.†

M. Hellmann also presented to the Committee a chart, upon which were traced in colours the countries of the globe for which observations have been published.

After a short discussion, M. Wild made the following proposal :—

Resolution A., p. 25.

This proposal was adopted by the Committee.

The letter from Mr. Parkinson to M. Wild was then read, in which Mr. Parkinson explained the desire of the Missionary Societies and of the Colonial Government of the Isles of Samoa, in the Pacific, to have several stations of the second order on the isles of the Archipelago. He offered to take the direction of the meteorological system, if provided with funds for this purpose.

The Committee did not think it could engage itself in this enterprise, and unanimously framed the following proposal :

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* Rapports sur les questions du Programme, p. 38.
† Ibidem, p. 46.

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Resolution B., p. 25.

Mr. Scott stated that in 1878 meteorological instruments had been sent to Norfolk Island, and that a report upon all the existing meteorological data for the Isles of Samoa had been presented to the Meteorological Society of London, in March 1879.

M. Hann asked for information as to the condition of the meteorological stations in South Africa.

Mr. Scott informed the Committee that Mr. Gill, the new Director of the Cape Town Observatory, had commenced the re-organisation of the meteorological service at that observatory, and that the Kew Observatory would, during the next summer, undertake the comparison of the standard barometers of Kew and Cape Town.

Mr. Scott added that a scheme of meteorological observations and of storm warnings for the Antilles had been presented to the British Government, and that he hoped to see it carried out.

M. Neumayer also informed the Committee that he possessed a series of nine years' observations made at Norfolk Island, but that the instruments used for the observations had not been verified.

After the reading of M. Mohn's report on question 32, above mentioned, and after a long discussion, in which all the members of the Committee took part, M. Plantamour was requested to frame the definitive proposal, which was as follows:

Resolution C., p. 25.

This proposal was put to the vote and adopted.

The next meeting was fixed for Friday, the 18th, at 9h. a.m.

The meeting rose at 11h. 30m. a.m.

F. DENZA, President.
WEYPRECHT, Secretary.

Second Meeting, Friday, 18th April, at 9h. a.m.

The meeting was opened by M. Denza, President. The protocol of the first meeting was read and confirmed. The discussion on questions 11 and 32 of the Programme was continued.

M. Mohn read the passages of his report (*see* the protocol of the preceding meeting) relative to the choice of instruments for distant stations.

At the request of Captain Hoffmeyer, a discussion was opened on the use of barometers. The great difficulties in the transit of mercurial barometers during long overland journeys was admitted.

M. Wild drew attention to the mercurial barometers which could be filled at the place of observation; and M. Tacchini mentioned in this respect the barometer of M. Uzielli.

The President observed that according to his own experience this barometer did not give accurately the tenths of millimetres.

It was agreed that this method of filling barometers during journeys was not safe, at least with the instruments we possessed at present, and that they could not be used without fear of error.

Captain Hoffmeyer requested information as to the reliance which could be placed upon aneroid barometers.

A detailed and interesting discussion ensued upon this subject between all the members of the Committee, from which the use of aneroids in journeys, and especially for the measurement of altitudes, was decided against, and it was admitted that at the utmost these instruments might be adopted exceptionally for observations at fixed and very distant stations, but always after having been compared with mercurial barometers.

M. Neumayer recommended the boiling-point thermometer for the determination of heights of mountains. The Committee, however, while acknowledging the utility of this instrument, especially in the hands of experienced observers, did not think its employment altogether safe and free from error.

The President opened the discussion upon question 26 of the Programme viz., "Have, since the last Congress, hourly meteorological observations been made at new, and especially Continental, stations within the Tropics." (See Report of the Fourth Commission, protocol of the sixth meeting of the Con-

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gress of Vienna, and its first supplement.) Mr. Blanford had presented a report upon this subject.*

The President requested Mr. Scott to give a resumé of Mr. Blanford's report above referred to, after which the resolution A, p. 26, was framed and adopted.

Mr. Scott brought to the knowledge of the Committee a communication from the Government of Brazil, in which the latter asked for an expression of opinion from the Congress as to the utility of a system of meteorological stations over the territory of that empire. This communication was welcomed with interest by the members of the Committee, who adopted resolution B., p. 26.

Mr. Scott drew attention to the proposal of Mr. J. Allan Broun, of the Trevandrum Observatory, who urged the continuation of the publication of observations made at his observatory.

Mr. Scott stated that this publication had been interrupted because the local Government had not granted the funds necessary for the purpose.

Mr. Plantamour thought that a subscription might be raised, but this proposal was not supported by the majority of the members.

After a short discussion, resolution C., p. 26, was framed.

The Committee adjourned to Monday, 21st April, at 4h. p.m.

The meeting closed at 11 o'clock.

F. Denza, President.
Weyprecht, Secretary.

Third Meeting, Monday, 21st April, at 4 p.m.

The meeting was opened by the President.

M. Weyprecht, the secretary, read the protocol of the second meeting, which was adopted.

He then presented the following proposal in the name of M. Schenzl:—

"There is no meteorological station at present beyond the eastern and southern frontier of Hungary. It seems to me, therefore, very desirable that the Congress should designate Bulgaria, Roumelia, Roumania, and Servia among the countries where the establishment of meteorological stations is declared to be important; as to Bosnia and Herzegovina, it should be remarked that the Central Meteorological Office of Vienna has already established meteorological stations of the third order there, and that consequently it would not be difficult to complete them."

After this communication, the President proposed to add the following resolution to those already adopted in reply to questions 11 and 32:—

Vide Resolution D., p. 26.

The President opened the discussion upon question 30 of the Programme.

"What observations do we possess from high mountains, and from balloon ascents, and what measures should be taken to organise these observations more completely."

MM. Hann† and Denza‡ have presented reports upon this question.

The President invited M. Hann to read the first conclusion of his report.

M. Hann read this conclusion.

M. Plantamour thought that it was impossible to determine accurately at the same time, the height of the balloon and the pressure of the air, owing to the influence which the ascensional motion of the balloon must exert on the barometer and thermometer.

M. Hann remarked that it was only in balloons that the influence of the ground could be eliminated, which was impossible at mountain stations, at whatever height they might be situated. He recommended observations in balloons as well as those at elevated stations.

M. Hoffmeyer recommended the comparison of observations made in balloons with those entered on synoptic charts.

M. Hann thought that the question should not be looked at from such or such particular point of view, but that the observations could only be analysed for the object which each investigator proposed in his researches.

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* Rapports sur les questions du Programme, p. 77.
† Ibidem, p. 53.
‡ Ibidem, p. 127

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M. Wild remarked that observations of this nature could only be utilised upon condition that they were published in detail. He therefore proposed to add to the first proposal of M. Hann the recommendation that observations made in balloons should be published *in extenso*.

This proposal of M. Wild was adopted, and the Committee finally decided that the vote of thanks that M. Hann had added at the end of his proposal should be suppressed. After this modification, M. Hann's proposal read as follows:—

Resolution A., p. 26.

M. Hann read the first part of the second proposal of his report, which was adopted without discussion, viz.: Resolution B*a*, p. 26.

Upon this subject the President remarked that in a few years the Direction of Italian Meteorology would publish *in extenso* all the meteorological observations of the stations of Valdobbia (8,360 feet), Stelvio (8,343 feet), and Little St. Bernard (7,087 feet), which are the most elevated among the Italian Alps.

M. Hann withdrew the second part of the second proposition, thanking several meteorologists who have established elevated stations (*see* Reports, p. 69). He then read the third part of his proposition, which was adopted without discussion:—

Resolution B*b*., p. 26.

M. Hann read the fourth part of the second proposition (Reports, p. 69).

A prolonged discussion ensued upon this subject among the members of the Committee.

MM. Plantamour, Scott, Denza, and Wild drew attention to the difficulties which observers placed on the summit of mountains had to combat, viz., snow, winds, the complete isolation of the observers, and also the curiosity of tourists during the fine season.

M. Snellen proposed to erect self-recording instruments at elevated stations, and to transmit their indications to a lower station by electric wire. This proposal was not adopted, because several members remarked that the maintenance would be very difficult, if not impossible, and that on the other hand, it could not remain long without attention.

The President said it would be impossible to establish meteorological stations on the summits of the Italian Alps, which were inaccessible during winter; and even in the fine season there was difficulty in reaching them. He thought, therefore, that the Committee should confine themselves to recommending for these mountains elevated stations, and even very elevated, although they were not placed quite upon the summits. Moreover the stations might also render great service to meteorology.

M. Plantamour reported to the Committee that he had been charged by the Swiss Government to communicate to the Congress that that country would be disposed to contribute to the establishment of stations on the summits of high mountains, but that it could not bear the whole cost of them.

He proposed the summit of Hohe Väntis in the canton of Appenzel as best situated, but he drew attention to the enormous expense which would have to be incurred to establish a good meteorological station at that place, and he concluded that contributions from other countries would be indispensable.

As the article of the Programme in which the Permanent Committee proposed the formation of an international fund had been rejected, the Committee did not think it could undertake such a proposition.

Ultimately M. Wild and other members proposed to modify the fourth part of the second proposal of M. Hann, in the following manner:—

"The Congress, while recognising the sacrifices which the Government of Switzerland has already made for meteorology generally, recommends the Swiss Society of Natural Sciences to do its utmost to promote the establishment of an observatory upon one of the high summits of Switzerland and other countries, &c."

This proposal was adopted provisionally, for the members of the Committee having other pressing engagements, the discussion was adjourned by the President until the next meeting, which was fixed for Tuesday, 22nd April, at 10h. a.m.

The meeting rose at 5h. 30m. p.m.

F. DENZA, President.
WEYPRECHT, Secretary.

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Fourth Meeting, Tuesday, April 22nd, at 10h. a.m.

The meeting was opened by the President, at 10h. a.m.

The Secretary read the protocol of the third meeting, which was confirmed.

The discussion on the fourth part of the third proposal of M. Hann was continued.

M. Snellen desired that this part should be modified, especially the part respecting Switzerland.

MM. Wild and Plantamour expressed the same desire.

The President requested M. Hann to read again the proposal in question, which was done.

The President drew attention to what he had stated in his report, viz., the great difficulty there was in finding, in the chain of the Italian Alps, an elevated and quite isolated peak, suitable for taking regular and continuous observations. He thought, therefore, that the Congress should approve also the establishment of mountain stations, as well as those already existing, provided that the circumstances are not altogether unfavourable for meteorology, and that the observations are made during the whole year.

Eventually the fourth part of M. Hann's second proposal was altered as follows :—

Resolution B*c.*, p. 27.

This proposal was adopted.

M. Hann read the fifth part of his second proposal (*see* Reports, p. 69).

The President brought to the knowledge of the Committee the scheme of M. Parenti for establishing a meteorological observatory on the summit of Mont Cimone, in the Appenines of Modena. He presented the printed programme of M. Parenti, and the plan of the observatory building, and at the same time stated that this would be the most favourable place available in the Italian mountains for the establishment of a meteorological station which would satisfy all the conditions desired by the Committee and by the Congress also.

Captain Hoffmeyer withdrew the recommendation that he had made in the second part of the proposal under discussion.

After some other less important remarks, the following proposal was framed :—

Resolution B*d.*, p. 27.

M. Tacchini thanked the Committee for the desire it had expressed respecting the observatory on Mount Etna, and presented to the members the plan of the building for the new station. He assured the Committee that the works would be begun next summer.

M. Hann read the third proposal of his Report (*see* Reports, p. 70).

The President repeated that for some years the Direction of Italian Meteorology had published *in extenso* a large part of the observations which were made at the three high meteorological stations of the Great and Little Saint Bernard and of the Stelvio.

M. Hann's proposal was adopted without alteration, viz. :—

Resolution C., p. 27.

The President declared the discussion on question 31 of the Programme open, viz. :—

"31. The Committee, after having taken cognizance of the project of M. Weyprecht to establish several observatories in the Arctic and Antarctic regions, so as to organise hourly meteorological and magnetical observations to be made simultaneously all around the Pole, are of opinion that those observations will be of the highest importance in developing meteorology, and in extending our knowledge of terrestrial magnetism. They think, therefore, that, in the interest of science, they should recommend general participation in this enterprise. In what manner can the Congress, on its part, contribute to the success of the enterprise ? "

MM. Buys Ballot* and Mohn† have drawn up reports on this question.

M. Weyprecht presented :

1°. A Note to the Royal Meteorological Society of Utrecht.

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* Rapports sur les questions du Programme, p. 17.
† Ibidem, p. 29.

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2°. A Speech read at the 48th Assembly of German Naturalists and Doctors at Prätz, 18th September, 1875: "Fundamental Principles of Arctic Exploration."

3°. Programme of Operations for an International Polar Expedition proposed by Count Wilczek and Charles Weyprecht.

The President called upon M. Weyprecht, who stated that three years ago Count Wilczek and he had formed the intention to undertake a scientific expedition to the northern coasts of Nova Zembla, for which Count Wilczek would furnish the necessary funds. The object of this expedition would be primarily to make continuous meteorological, magnetical, and hydrographical observations, and also observations on the Aurora Borealis during an entire year.

In order that these studies should be satisfactory and conclusive, synchronous observations were necessary at different points of the Arctic and Antarctic regions. For this reason an attempt has been made to promote other small expeditions. Experience, however, had shown that it was a task too serious and difficult for private persons.

But not being able indefinitely to postpone the execution of this scheme, M. Weyprecht asserted that he had decided to start upon the expedition next year, 1880.

With this object in view, Count Wilczek and he asked the Congress:

If it would undertake to provide for the sending out of other simultaneous expeditions, or if it could arrange that after a year another expedition should take the place of the first, in order to continue the observations commenced for another year. M. Weyprecht remarked, in conclusion, that if the proposed expedition should remain isolated, they would adhere rigorously to all the details of the programme of operations already proposed and presented to the Congress. If, on the contrary, they could hope to have certain and definite promises before the end of next September, which were indispensable for the choice and fitting out of the vessels, M. Weyprecht, in the name of Count Wilczek, undertook to postpone the expedition for a year longer, viz., until 1881, and he declared also that he was disposed to submit the proposed programme for discussion.

After this communication a discussion ensued between the members of the Committee.

M. Neumayer thought that Antarctic regions should be included also in the scheme, and that it would be desirable to create a colonial direction for the *advanced* stations to be established for polar meteorology, and he proposed stations at the islands of Kerguelen and Auckland, and perhaps a station of the second order at Punta Arenas.

He desired that the Congress should recognise the necessity of Antarctic meteorological researches, and he announced that he was authorised by the German Government to make this recommendation; and that from the year 1880 the latter would be disposed to allow him to undertake observations in the Antarctic regions by placing at his disposal a vessel of the Imperial Navy.

M. Wild, while acknowledging the importance of Antarctic explorations, thought that, for the purpose of attaining the end proposed, we should not undertake too many things, but that for the present it would be indispensable to confine ourselves to simultaneous observing stations in the Arctic regions, of which he admitted the great utility.

M. Hann withdrew the fourth proposal of his Report (*see* reports, p. 70).

M. Bruhns affirmed that with this object use could advantageously be made of the meteorological and magnetical observations of Chili and of Melbourne. He thought that the Committee should express its opinion on this matter. He considered, however, that Antarctic researches should also be included in proposal 31 of the Programme.

M. Mohn was of the same opinion; he thought that Arctic and Antarctic studies should progress at the same time.

M. Plantamour said he did not understand the great meteorological importance that high northern regions might have for the climate of Europe.

M. Neumayer drew attention to the great importance which local circumstances in southern latitudes have upon the climatology of the globe.

M. Hoffmeyer inquired whether the Congress could accept in its Programme studies upon terrestrial magnetism. He thought the Congress ought to occupy itself especially with meteorology.

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M. Rubenson reported that a committee had been appointed in Sweden to study this question.

MM. Wild, Mohn, Scott, and Denza also thought that magnetic observations should be carried out together with meteorological observations, especially in the actual question, for advantage should be taken in every way of Polar expeditions, which are certainly not too frequent.

Several members then remarked that they had no definite instructions upon this question.

After other remarks and propositions by various members, it was ultimately decided to frame the resolution given at p. 28 :

The resolution was adopted.

The meeting was adjourned until 3h. p.m.

The President closed the meeting at noon.

F. DENZA, President.
WEYPRECHT, Secretary.

Fifth Meeting, Tuesday, 22nd April, at 3h. 45m. p.m.

This meeting should be considered as as a continuation of the morning meeting.

The Committee discussed the question about glaciers proposed by M. Hann to the Permanent Committee (*see* Report of the Permanent Committee, the First Meteorological Congress of Vienna, meeting at Utrecht, 1878, p. 2), and upon which several communications, mentioned at the first meeting of the Committee, had been presented to the Congress.

After a short discussion, the Committee adopted the resolution given at p. 27.

The President then declared the discussion of the questions referred to the Committee closed.

The President afterwards read all the resolutions which had been framed by the Committee, in order to correct them and to prepare them for presentation to the Congress.

The meeting rose at 4h. p.m.

F. DENZA, President.
WEYPRECHT, Secretary.

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APPENDIX XI.

Questions.	Resolutions.
1. Regulations for the Second International Congress of Meteorologists, prepared by M. Bruhns.	Adopted at the first meeting (p. 1).
2. Report of the Committee on its action during the interval between the First and Second Congress, prepared by Mr. Scott.	Read at the first meeting of the Congress (p. 2).
3. Report on the conformity with each other, and with the decisions of the Congress of Vienna, of instruments, methods of observation, and publication of observations in the different countries.	The Congress decides that the English report mentioned by Mr. Scott be translated into French and German and published as Appendix V. to the Report of the present Congress. At the same time it requests the future Committee to make such a report for the next Congress respecting the conformity of the methods, &c. with the decisions of the Congresses of Vienna and Rome (p. 9).
4. M. Buys Ballot is requested to prepare a report on the methods employed in the different countries for obtaining true daily means from the various combinations of hours of observation.	The Congress proposes that each country be invited to establish at a certain number of points, regard being paid to local conditions, stations at which continuous observations should be made by means of self-recording instruments, or else hourly observations during several term-days in each month, or lastly continued, equidistant, and frequent observations (eight times a day at least), in order to obtain the necessary data for reducing to true means the means of observations made twice or thrice a day at ordinary stations (p. 20).
5. The Committee proposes the general adoption of the forms of publication already introduced in several countries for observations at a certain number of stations of the second order chosen in each country as international stations. (See the Reports of the Committee for 1873 and 1874, p. 9, third meeting at Utrecht, and Appendix F.)	The Congress adopts proposal No. 5 in the form in which it has been proposed by the Permanent Committee (p. 20). The monthly and yearly resumés published by the central offices for the different stations, contain, in accordance with the resolutions of the Congress of Vienna, a summary of the frequency of the eight principal directions of the wind, both for the months and for the year. Seeing the importance which must be attached, not only to the direction but also to the *force of the wind*, the Congress proposes (in accordance with M. Weihrauch's proposal) to publish also in these summaries the *mean force* of each wind, and for the greatest possible number of stations for each month and for the year. Where the form adopted allows sufficient space, the figures representing the frequency and the mean force should be placed side by side; otherwise it is preferable to give both in the form of an appendix (p. 20). The observation of the direction of the upper clouds, and especially of cirrus, at some stations of each country, and the publication of these observations in the form of an appendix, is strongly recommended (p. 22,) and also the publication of observations on the temperature of the surface of the ground. (Question 18) (p. 23).
6. The Committee recommends the general adoption of the code of figures for meteorological telegrams proposed at its fourth meeting at Utrecht. (See the above Reports, pp. 12 and 14.)	Adopted.—See question 27.
7. The Committee is of opinion that it is impossible at present to compile general instructions adapted in their details to the special peculiarities of all countries and all climates. It proposes, therefore, that the Congress should confine itself, in the case of any one demanding typical instructions, to designating those of the existing instructions which are most conformable to the decisions of the Congress.	The directors, whose names are given in the following list, announced that their instructions were in general conformity with the regulations of Vienna:— MM. v. Bezold - Bavaria. Houzeau - Belgium. Hoffmeyer - Denmark. Scott - England. Mascart - France. Neumayer - Germany (Deutsche Seewarte). Snellen - Holland. Cantoni - Italy. Mohn - Norway. Capello - Portugal. Wild - Russia. Bruhns - Saxony. Aguilar - Spain. Rubenson - Sweden. Plantamour - Switzerland (p. 9).
8. The Committee proposes to establish, by small annual contributions from all countries taking part in the Congress, an international fund, for the expenses incurred by such joint undertakings as those named in the following sections, and the expenses of postage and printing for the Congress and its Permanent Committee.	The Congress resolves not to carry out the eighth proposal of the Programme relative to the formation of a small international fund by means of small annual contributions by all the countries taking part in the Congress (p. 17).

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Questions.	Resolutions.
9. The Committee requests the delegates to prepare for the Congress at Rome a catalogue of the meteorological observations, both published and unpublished, in their respective countries. M. Hellmann proposes to add thereto a catalogue of meteorological works and memoirs. M. Pittei proposes the publication of an International Meteorological Dictionary.	The Congress states with pleasure that very valuable preliminary works corresponding to article No. 9 of the Programme and to M. Hellmann's proposal have been already partly executed; but as it is to be desired that these materials should be collected in a general catalogue, The Congress proposes that these publications be divided into two categories:— 1°. A catalogue of series of observations. 2°. A catalogue of meteorological works and memoirs. As to the first category the directors of the different meteorological systems are invited to prepare catalogues of the published and unpublished observations in their respective countries, and to inform the International Committee of the work already done in that direction. As to the second catagory, the Congress is of opinion that the works already done by Professor Cleveland Abbé, and the catalogues already printed of the library of the Meteorological Society of London, and of the Observatory of Brussels, might well serve as a starting point for more comprehensive publications, and invites all the directors of other meteorological libraries to add the list of works and memoirs which are not yet entered in these catalogues (p. 21). The Congress is of opinion that it would be very useful that an international dictionary of meteorology should be published (p. 22).
10. The Committee proposes to have a comparison made of the standard barometers and thermometers of all the meteorological institutes by referring them to a certain barometer and thermometer, which for the time being, appear to be the best verified. Inasmuch as the International Office of Weights and Measures of Paris will be in possession of such verified standard instruments, a comparison should be instituted with them, and they should serve as a basis for all corrections. At the same time any questions about accurate height above sea level of standard barometers should be raised.	The Congress recommends the directors of all central institutions to have their instruments compared with the standard instruments of other countries (p. 12).
11. The Committee draws attention to the importance of establishing distant stations and supplying them with the necessary instruments.	The Congress expressed the opinion that the cost of establishment and maintenance of distant stations should not be borne by an international fund, but at the expense and under the care of the countries which are in relation with those localities (p. 25).
12. The Committee is of opinion that the establishment of an international meteorological institute is at present not possible, nor even desirable, and proposes to provide for the functions and labours which might devolve upon such an institution in the following manner: (*a.*) The international administrative functions, such as the execution of the decisions of the Congress, the convening of future Congresses, the care of joint international investigations and undertakings, the administration of the international fund, &c., will be confided, as is already partly the case, to a *Permanent Committee* elected from time to time by a Congress, and required to give an account of its action to the next Congress. (*b.*) As regards researches which embrace a considerable portion of the globe, for the purpose of deducing general laws in meteorology, it is desirable that permanent relations for the communication of materials should be established between the different central institutes, and that the publications appearing in each country should be distributed gratuitously to all institutes and to all persons who take part in the investigations. These publications are to be, moreover, rendered generally accessible through the agency of booksellers. These international investigations will be based upon the publication of the	The Second Meteorological Congress assembled at Rome institutes an *International Meteorological Committee*, which is charged with everything that concerns international relations until the meeting of a future Congress. The Committee is composed of nine members elected by ballot, under the restriction that two delegates of the same country cannot hold seats on it at the same time. In case of vacancy by the resignation or by the death of one of its members, the Committee may complete itself by the co-opton of a new member, having regard to the restriction above indicated. The Committee elects its own executive officers and distributes its labours among the different members. The Committee is charged with the publication of the Report of the present meeting in three languages, English French, and German (p. 29). With seeing that the decisions of the Congress are carried out, with the convening of future Congresses, with the preparation of the questions which should be submitted to this Congress, with the keeping of the delegates to the present Congress informed of its proceedings and of its decisions, and lastly, with the presentation to the next Congress, at the expiration of its functions, of a report embracing the whole of the period (p. 16). The Congress is of opinion that a new Congress should be convened after a maximum interval of five years* (p. 17).

* Note.—The Committee elected by the Congress was composed of the following members: MM. Buys Ballot, Cantoni, de Brito Capello, Hann, Mascart, Mohn, Neumayer, Scott, Wild. At its first meeting M. Wild was elected president and Mr. Scott secretary. It was further arranged that the Committee should give timely notice of all its meetings to meteorologists interested in its proceedings (p. 29).

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QUESTIONS.	RESOLUTIONS.
observations of each country according to the international form, and, besides, on the special labours which each country may be willing to undertake with regard to its own climate. In the case of supplementary information being required for any countries it is desirable that a suitable system of reciprocal communications should be devised.	
13. The Committee considers the following subjects as possessing a general interest: (*a.*) Critical collection and discussion of all existing data on the diurnal range of air temperature, and attempts to deduce general laws therefrom. (*b.*) Critical collection and discussion of all existing data on the diurnal and annual range of absolute and relative atmospheric humidity, and attempts to deduce general laws therefrom. (*c.*) Critical collection and discussion of all data on the diurnal and annual range of the state of the sky, that is, of the amount of cloud. (*d.*) Wind tables for the 12 months and for the year. (*e.*) Tables of precipitation for the 12 months and for the year. (*f.*) New tables of atmospheric pressure, with isobars, for the 12 months and for the year. (*g.*) Charts of the movements of storm. (*h.*) Daily synoptic charts, embracing considerable portions of the globe.	As regards researches which embrace a considerable portion of the globe for the purpose of deducing general laws in meteorology, it is desirable that permanent relations for the communication of materials should be established between the different central institutes, and that the publications appearing in each country should be distributed gratuitously to all institutes and to all persons who take part in the investigations. These publications are to be, moreover, rendered generally accessible through the agency of booksellers. The Congress considers the subjects enumerated in question 13, among others, as possessing a character of general interest. The directors of the central institutions are invited to have these works executed as soon as possible for the stations of their respective countries and published, in order that they may serve as a basis for researches which may be undertaken on the general march of meteorological phenomena over the surface of the globe. Before undertaking the investigation of any one of the above-mentioned subjects, the public establishments are invited to acquaint the President of the International Committee of their intention, and he will inform the directors of all the central institutions (p. 17).
14. The Committee proposes to organise, in connexion with the Congress at Rome, an exhibition, as complete as possible, of the instruments of observation used in the different counties, and it requests meteorologists to contribute thereto by sending either instruments or designs to Rome.	The Congress expresses the opinion that it is desirable that the central institutions should possess specimens of the principal instruments actually in use in other countries (p. 28).
15. The Committee recommends the establishment of rules and formulæ for reducing barometric readings to the sea level in a uniform manner. Supplementary proposition by Dr. Hellmann to prepare a new set of tables for reduction.	(1.) The reduction to the sea level by the addition of a constant quantity during the whole year is only admissible for heights not exceeding 20 metres, if we wish to obtain an accuracy of ± 0·5 mm. (±0·002 in.). Consequently, for stations situated at a height exceeding 20 metres, account must be taken of the temperature and approximately of the relative humidity, according to Laplace's method. (2.) In weather reports it is desirable that the barometric readings unreduced should be given by the side of the readings reduced to the sea level; in other publications it is *necessary* to have in all cases unreduced readings. (3.) It is desirable that the International Meteorological Committee should undertake the compilation of fresh uniform tables for the reduction of barometric readings to the level of the sea. (4.) It is equally desirable that the Committee should undertake the preparation of a collection of tables which may be employed in the meteorological systems of the different countries (p. 22).
16. The Committee proposes the establishment of uniform rules for determining the fixed points of thermometers.	The Congress is of opinion that the method indicated in M. Pernet's report on the determination of the fixed points of thermometers should be provisionally accepted (p. 12).
17. Can definitive rules now be established for the most suitable exposure of thermometers destined to give the temperature of the air?	The Congress, without actually prescribing a fixed form of thermometer screen suitable for different climates, and even for the exigencies of observers, draws the attention of meteorologists to the reports and communications presented to the Congress, either as printed papers, or in the protocols of the meetings of the Committee (p. 12).
18. Have additional comparative experiments been made since the first Congress for forming an opinion of the different methods for determining earth temperature, which give more definite information as to their relative value? M. Wild's proposal relating to observations of the surface temperature of soil.	The Congress has not been informed of any new experiments made on this subject since the date of the Vienna Congress, and in conformity with M. Wild's suggestion, proposes to admit the temperature of the surface of the earth among the meteorological elements to be observed at stations of the second order (p. 13).
19. Have decisive experiments been made since the first Congress to find a simple and appropriate method for determining radiation, and what is the relation between this and the amount of aqueous vapour in the atmosphere?	The Congress finds that the researches into the subject of radiation are not yet sufficiently advanced to enable it to propose a method of observation, and considers that the question should be referred to the next Congress (p. 13.)

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Questions.	Resolutions.
20. What progress has been made in methods for determining the humidity of the air?	The Congress recommends the employment, as far as may be possible, of a regular arrangement for ventilation in the determination of the humidity of the air by means of the dry and wet bulb thermometers (p. 13).
21. What progress has been made in the methods of determining evaporation?	The Congress points out that atmometers generally should fulfil certain conditions of comparability, and expresses the opinion that there is need of fresh researches being undertaken, for the determination of the form and exposure of the instruments to be employed (p. 13.)
22. Is there any reason to change, after further experience, the decisions of the first Congress respecting the instruments and methods for measuring the quantity of rain or snow?	The Congress thinks, that for stations of the second and third order, a diameter of eight or even of four inches is sufficient for the rain gauge. As to the position of the rain gauges the Congress confines itself to recommending that they should never be placed upon a roof, but that they should be sufficiently elevated to be out of the influence of drifting snow, and of the splashing of drops from the ground, while they must not be sheltered by trees or other neighbouring objects (p. 13).
23. How many absolute values of the velocity of the wind be deduced from the direct indications of different anemometers?	The Congress does not feel itself prepared at present to reply to the question of the determination of wind velocity. It confines itself to recommending the directors of central institutions to effect a comparison between the anemometers employed in different countries (p. 14). If the future International Committee finds that the question is sufficiently advanced, it is to propose an international comparison of anemometers (p. 14).
23a. M. Hildebrandsson's proposal for the observations of "cirrus" clouds.	The observation of the direction of the upper clouds, and especially of cirrus, at some stations in each country, and the publication of these observations in the form of an appendix is strongly recommended (p. 22).
24. Have since the last Congress better methods been discovered for measuring the ozone in the atmosphere?	The Congress thinks that the difficult question of the determination of ozone does not in its present condition permit of a definite solution (p. 15).
25. What progress have the methods for determining atmospheric electricity made, and what results have observations of this kind furnished hitherto?	The Congress is of opinion that the study of atmospheric electricity has made marked progress in recent years, and recommends that a comparison should be made between the instruments which are most generally used. (p. 15.)
25a. Proposal of M. de Rossi for observations of earthquake phenomena.	After having heard with interest the Report of M. de Rossi on the phenomena, which he comprises under the term "Endogenous Meteorology," the Congress expresses such desire to see such researches continued and insists upon the relations which may exist between them and those of general meteorology (p. 15).
26. Have, since the last Congress, hourly meteorological observations been made at new, and especially continental, stations within the tropics? (See Report of the IVth Commission, Protocol of the Sixth Meeting of the Congress of Vienna, and its First Supplement.)	A. The Congress expresses the desire that the hourly observations made at the existing tropical stations may be continued, and that other analogous observatories may be established, especially in the interior of the continents of the Torrid Zone. B. The Congress, recognising the great importance that meteorological stations in Brazil would possess for the progress of science, begs the Italian Government to make this desire known to the Government of that country. C. The Congress decides upon conveying to the Royal Society of London their expression of the importance it attaches to the continuation of the publication of the observations made at Trevandrum by Mr. J. Allan Broun, and upon requesting that Society to be good enough to take steps to this effect (p. 26).
27. What progress has meteorological telegraphy made since the first Congress, and how can we contribute to its development?	The Congress recommends for meteorological telegrams the general adoption of the code of figures proposed by the Permanent Committee at Utrecht, and states that the Report which has been presented by Mr. Scott to the Congress on the present condition of meteorological telegraphy contains some information with reference to question 27 (p. 23).
28. What progress has maritime meteorology made since the First Congress?	The Congress expresses the opinion that the Maritime Conference at London in 1874 has fulfilled the conditions prescribed by the Congress of Vienna for the study of maritime meteorology; it is of opinion also, that in order to ensue the future progress of this branch of meteorology the most perfect liberty should be accorded to the institutions interested in making mutually the arrangements which are most suitable for the execution of their investigations (p. 23).
29. What results have the simultaneous observations given, and how may we contribute to their further development?	The Congress is of opinion that the development of simultaneous observations contributes greatly to the progress of meteorology, and that all work done in this direction should be encouraged (p. 24).
30. What observations do we possess from high mountains and from balloon ascents, and what measures should be taken to organise these observations more completely?	A. The Congress, recognising the importance that observations made in balloons, especially at places situated in the interior of the continents, may have for the physical study of the higher regions of the atmosphere, recommends the taking of observations of temperature and humidity by means of captive balloons, and according to Glaisher's method, in strata at different heights, and on different days and in different seasons. It recommends also the study, by means of captive balloons, of the diurnal range of temperature and humidity in the upper strata of the atmosphere and the detailed publication of these observations (p. 26).

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Questions.	Resolutions.
	Ba. The Congress thinks that it would be very useful if observatories could possibly be established on the summits of mountains, and the observations published *in extenso*, so that they may be placed at the disposal of all meteorologists, and may aid in the solution of problems which may present themselves in future (p. 26).
	Bb. The Congress insists upon the utility of a series of hourly observations of temperature, pressure, direction, and force of wind, and eventually also of humidity on Mount Washington, and especially at Pike's Peak, the highest station upon the earth. This series should embrace one year at least; and it would also be desirable to publish in detail the observations already existing for these two stations. General Myer is requested to be good enough to realise these desires of all meteorologists (p. 26).
	Bc. The Congress recommends the Swiss Society of Natural Sciences to do its utmost to promote the establishment of an observatory upon one of the high summits of Switzerland. It expresses the desire that meteorological stations may be established under similar conditions in Italy and other countries (p. 27).
	Bd. The Congress considers the establishment of the observatory of Etna, proposed by M. Tacchini, of that of Mont Cimone, proposed by M. Parenti, and that of Mont Ventoux, supported bp the Meteorological Commission of the Department of Vaucluse, as enterprises of high scientific importance (p. 27).
	C. The Congress requests the directors of the meteorological systems of the various countries to be good enough to publish in a complete manner the existing series of observations made at elevated stations, and which have either not yet been published, or only in an incomplete manner; and at the same time to indicate and describe the stations of their systems which might furnish materials for the study of the upper regions of the atmosphere (p. 27).
30a. Proposal by M. Hann for the measurement of the variations in length of glaciers.	The Congress draws the attention of meteorologists to the importance of measuring the variations in length and thickness of the glaciers in the different countries in order to be able to deduce the relations which exist between these variations and those of the meteorological elements. As a means of extending our knowledge upon this question the Congress recommends:— To form a complete critical collection of observations made in times past upon the variations of volume of the glaciers. To institute in future continued observations at localities suitably chosen, upon the annual variations of the glaciers in length and thickness and to publish the results. The Congress hopes to be able to rely upon the co-operation of the Alpine Clubs and other analogous societies in carrying out these researches (p. 27).
31. The Committee, after having taken cognizance of the project of M. Weyprecht to establish several observatories in the Arctic and Antarctic regions, so as to organise hourly meteorological and magnetical observations to be made simultaneously all around the Pole, is of opinion that those observations will be of the highest importance in developing meteorology, and in extending our knowledge of terrestrial magnetism. It thinks, therefore, that, in the interest of science, it should recommend general participation in this enterprise. In what manner can the Congress, on its part, contribute to the success of the enterprise?	The Congress recognises the great importance which should be attributed to synchronous meteorological and magnetical observations made in the Polar regions by means of simultaneous expeditions, and it recommends all Governments to give the most effective support to such undertakings. Considering— 1°. That the majority of the members of the Congress are not provided with instructions relating to this question; 2°. That such instructions are absolutely necessary in order to arrive at definite resolutions. The Congress decides to entrust the International Committee with the convening of a special Conference, which should be composed of delegates provided with the necessary instructions and powers by their Governments, who may think they could participate in some way with the enterprise. By reason of the preparations already made by M. Weyprecht and Count Wilczek for an expedition of this nature, it thinks it necessary that this Conference should meet at Hamburg on the 1st of October 1879, in order to settle the details of the scheme and the means of carrying it out (p. 28).
32. In what manner should we proceed to establish meteorological stations in distant countries where observations have not hitherto been made? *Vide* Question 11.	The Congress cannot give effect to the proposal of Mr. Parkinson, who has asked for funds for organising a meteorological service in the Samoa Islands, because it has no international fund at its disposal; but with regard to the importance of this proposal, it expresses the hope that private initiative will permit of meteorological observations being taken in the Samoa Islands (p. 25). The Congress considering,— 1°. That it is of the highest importance that the meteorological stations established by different countries in parts of the globe, which are very remote and difficult of access, may be visited from time to time, in order to ascertain the accuracy of the instruments and of the amount of confidence which can be placed in the observations.

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Questions.	Resolutions.
	2°. That such an inspection may be most conveniently made by officers of the navies of the maritime powers, Proposes to forward to the Governments of the countries represented at the Congress the request that they will kindly take the necessary steps that, on the one hand, the officers commanding vessels visiting those parts may receive instructions, in pursuance of which they would place themselves in communication with the observers at those meteorological stations, whatever be the nationality of the latter, for the purpose of comparing the instruments, and of acquainting themselves with the manner in which the observations are made; and on the other hand, that the observer charged with the care of the station may place himself at the disposal of the officer visiting it, whatever be the maritime power by which he is commissioned (p. 25).
	The Congress recognises that the establishment of meteorological stations in Bulgaria, Roumania, and Servia, would be of the highest importance, and it begs the Italian Government to cause this wish to be communicated to the Governments of those States (p. 26).
33. Should we not recommend the general adoption of a certain first meridian, for example, that of Greenwich, for synoptic charts?	The Congress recommends the adoption of the meridian of Greenwich as a starting point for the construction of synoptic meteorological charts (p. 11).
	In the event of another meridian being used in the construction of meteorological charts, the Congress recommends that an indication should be given upon the chart of the difference of longitude between the first meridian adopted and the meridian of Greenwich (p. 11).
34. In what manner can we best organise and develop the construction and publication of synoptic charts embracing considerable portions of the globe?	A proposition made by MM. Hoffmeyer and Neumayer for combined work on a uniform plan on the preparation of the synoptic charts of M. Hoffmeyer and of the monthly review of the Deutsche Seewarte at Hamburg having been submitted to the Committee and discussed by it, the following resolution was adopted: The Congress fully appreciates the importance of the publication which the meteorological institutes of Copenhagen and Hamburg propose to undertake, and it hopes for the realisation of this project (p. 24).
35. How can the development of meteorology in connexion with agriculture and forestry be forwarded by the Congress?	In order to contribute to the progress of agricultural and forest meteorology, the Congress recommends as a programme for study— 1°. The influence of the meteorological elements upon vegetation. 2°. The inverse influence of vegetation upon the meteorological elements 3°. Agricultural warnings. The Congress, finding the subject too important to take a detailed resolution at this meeting, proposes to charge the International Committee with the convening of a special international conference before next spring, to take into consideration the development of agricultural and forest meteorology (p. 24).

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APPENDIX XII.

List of Reports presented to the Congress.

Those marked * are printed either in full or in abstract in "Rapports sur les Questions du Programme."

Those marked thus † were also printed privately, and were distributed at the Congress.

Those marked thus ‡ have been published independently of the Rapports.

Articles of the Programme.

4. Sur la Réduction des Moyennes des Observations en vraies Moyennes.—Prof. Buys Ballot.*†
8. On the Proposal for the Establishment of an International Fund.—Prof. Bruhns;*† Prof. Wild.*†
9. On the proposal for a Catalogue of Meteorological Publications.—Prof. Wild;*† Dr. Hellmann.‡ (1)
10. On the Comparison of Standard Instruments.—Prof. Wild;*† Dr. Neumayer.†
11. On the Establishment of Distant Stations (see Art. 32).
15. On Tables for Reducing Barometrical Readings to Sea-level.—Prof. Bruhns;*† Prof. Wild;*† Prof. Hann (see Art. 27); Dr. Hellmann.‡(2)
16. On the Determination of the Fixed Points of Thermometers.—M. Pernet.*†‡ (3)
17. On the Exposure of Thermometers.—Mr. Buchan;‡(4) Prof. Cantoni;*†(5) M. de Brito Capello.*†
18. On Earth Temperature.—Prof. Ebermayer;*† Prof. Wild.*†
19. On Solar Radiation.—M. Violle;*† M. Marié Davy.*
20. On Atmospheric Humidity.—Prof. Cantoni.*‡(5)
21. On Evaporation.—Prof. Cantoni;*‡(6) Prof. Ebermayer.*†
22. On Rain-gauges.—Prof. Mohn.*†
23. On Anemometry.—M. de Brito Capello;*† Prof. Wild.*†
24. On Ozone.—Prof. Palmieri.*
25. On Atmospheric Electricity.—Prof. J. D. Everett*†‡(7); Padre F. Denza.*
26. On Hourly Observations between the Tropics.—Mr. H. F. Blanford.*†
27. On Weather Telegraphy.—Mr. R. H. Scott*†‡(7); Dr. J. Hann*†‡(8); Dr. C. Pittei*; M. Rikatcheff.*†
28. On Maritime Meteorology.—Mr. R. H. Scott*†‡(7); Dr. G. Neumayer*†; Dr. C. Pittei*; M. Rikatcheff.*†
29. On Simultaneous Observations.—Prof. Buys Ballot.*†
30. On Observations at Mountain Stations and in Balloons.—Dr. Hann‡†; Padre Denza.*
31. On Stations in the Arctic Regions and M. Weyprecht's plan.—Prof. Buys Ballot*†; Prof. Mohn*†; Dr. Neumayer†; M. Weyprecht.†
32. On Distant Stations.—Prof. Mohn*†; Prof Wild.*†
33. On the Choice of a First Meridian.—Prof. Bruhns.*†
34. On Synoptic Charts.—Capt. Hoffmeyer*†; M. Brault.*†
35. On Agricultural Meteorology.—Dr. Lorenz von Liburnau*†; Prof. Bruhns*†; Padre Denza.*

Additional Propositions.

On the Isobars of the Globe for January and July.—Dr. Woeikoff.*†
On the Importance of a Meteorological Dictionary.—M. C. Pittei.*
On Endogenous Meteorology.—Prof. E. De Rossi.*†
On the Observations of Cirrus Clouds.—Prof Hildebrandsson.*†

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(1) Zeitschrift der Oest. Met. Gesellschaft, vol. XIV., page 94.
(2) Ibidem, page 97. (3) Ibidem, page 130.
(4) "Nature," vol. XV., page 556.
(5) Meteorologia Italiana, 1878. Memorie et Notize, fasc. 4, page 51.
(6) Ibidem, page 67.
(7) Published by the Meteorological Council, London.
(8) Zeitschrift der Oest. Met. Gesellschaft, vol. XIV., page 82.

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LIST OF PUBLICATIONS, &c. issued under the authority of the Meteorological Council.

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No.

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3. Fishery Barometer Manual. 6d.
4. Charts of Surface Temperature, South Atlantic Ocean. 2s. 6d.
5. Report for 1868. Presented to Parliament. 9d.
6. Report for 1869. Presented to Parliament. 10d.
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9. Quarterly Weather Report, 1870.—Parts I. to IV. 3s. each.
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11. Contributions to our Knowledge of the Meteorology of Cape Horn and the West Coast of South America. 2s. 6d.
12. Currents and Surface Temperature of the North Atlantic Ocean, from the Equator to Lat. 40° N., for each month of the year, with a General Current Chart. 3s. 6d.
13. A Discussion of the Meteorology of the Part of the Atlantic lying North of 30° N. for the Eleven Days ending 8th February 1870. Text, with Book of Charts. 5s.
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15. Report for 1871. Presented to Parliament. 10d.
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18. Contributions to our Knowledge of the Meteorology of the Antarctic Regions. 2s.
19. Quarterly Weather Report, 1873.—Parts I. to IV. 3s. each.
20. Charts of Meteorological Data for Square 9, Lat. 0°–10° N., Long. 20°–30° W., and Remarks to accompany the Monthly Charts. [illegible] On Best Routes across the Square for each Month. 3s.
21. Report of Proceedings of the Meteorological Congress at Vienna. 1s.
22. Report for 1873. Presented to Parliament. 4d.
23. Report of the Proceedings of the Conference on Maritime Meteorology held in London, 1874. 3s.
24. Instructions in the Use of Meteorological Instruments. 1s. 6d.
25. Quarterly Weather Report for 1874. Parts I. II. and IV. 3s. each. Part III. 5s. 6d.
26. Report for 1874. Presented to Parliament. 3d.
27. Charts of Meteorological Data for the Nine 10° Squares of the Atlantic which lie between 30° N. and 40° N., and extend from 10° to 40° W., with accompanying Remarks. 14s.
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29. Report for 1875. Presented to Parliament. 4d.
30. Quarterly Weather Report, 1875.—Parts I., II., III., and IV. 3s. each.
31. Report for Period of Seventeen Months ending 31st May 1877. Presented to Parliament. 3s. 6d.
32. A Discussion of the Meteorology of the North Atlantic during August 1873, with 31 Synoptic Charts. 15s.
33. Quarterly Weather Report for 1877. Part I. (In the Press.)
34. Contributions to our Knowledge of the Meteorology of the Arctic Regions. Part I. 2s. Part II. (In the press.)
35. Report for 1877–8. 1s.
36. Report of the Proceedings of the Meteorological Congress at Rome, 1879. 1s. 6d.
37. Report on the Meteorology of Mauritius. By the Rev. S. J. Perry, S.J., F.R.S. (In the Press.)

NON-OFFICIAL.

No.

1. Report to the Committee on the Connexion between Strong Winds and Barometrical Differences.—By R. H. Scott, Director of the Office. 6d.
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3. Report to the Committee on the Use of Isobaric Curves.—By Captain H. Toynbee, Marine Superintendent. 1s.
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11. Report of the Permanent Committee of the Vienna Congress for 1876. [illegible]
12. Reports to the Permanent Committee of the Vienna Congress on Atmospheric Electricity, Maritime Meteorology, and Weather Telegraphy. [illegible]
13. Report of the Permanent Committee of the Vienna Congress [illegible]

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REPORT

OF THE

INTERNATIONAL METEOROLOGICAL COMMITTEE.

MEETING AT BERNE, 1880.

Published by Authority of the Meteorological Council.

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REPORT

OF THE

INTERNATIONAL METEOROLOGICAL COMMITTEE.

ROME, 1879.

First Meeting of the International Meteorological Committee.

THE MEETING was held at the Ministry of Agriculture at Rome, on Tuesday, April 22, 1879, at 1h. 15m. p.m.

Present: MM. Cantoni, Capello, Hann, Mascart, Mohn, Neumayer, Scott, and Wild.

The Resolution of the Congress constituting the Committee was read, and the members proceeded to the election of a President and Secretary, in accordance with Article X. of the Byelaws for the Congress at Rome.

M. Wild was elected President.
Mr. Scott „ Secretary.

It was resolved that all communications made to the Committee should be addressed to the Secretary.

The Secretary was requested to deposit the original Protocols of the Meetings of the Permanent Committee of the Vienna Congress in the Meteorological Office in London.

H. WILD.

9th August 1880.

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BERNE, 1880.

Protocol of the First Meeting of the International Meteorological Committee, the 9th August 1880, at Berne.

Present: M. Wild, President. MM. Buys Ballot, Cantoni, Capello, Hann, Mascart, Mohn, Neumayer, and Mr. Scott, Secretary.

THE MEETING was opened at the "Observatoire Tellurique," Berne, at 10h. 15m. a.m.

The PRESIDENT welcomed the members of the Committee, and expressed the hope that the deliberations which were to take place on this occasion would produce results useful for the progress of science.

Upon the proposal of the PRESIDENT it was agreed that the Committee might invite those Meteorologists who were present at Berne, and who had made communications to the Committee on certain points of the Programme, &c., to take part in the discussion on their communications, but that in each particular case the Committee should pass a resolution as to the person to be invited.

It was agreed that the official language to be used by the Committee for the protocols, &c. should be French, but that everything should be translated and published in German and English as well, and that the members of the Committee might speak in another language if they wished to do so.

The protocol of the first meeting of the Committee at Rome, on the 22nd April 1879, was read and confirmed.

The Report of the Secretary was read and adopted. (Appendix I., p. 12.)

The PRESIDENT proposed a programme of the questions to be discussed at the Meetings, and at the same time he requested the members to bring forward any proposals which they wished to communicate to the Committee. This programme was adopted (Appendix II., p. 26).

Article VII. of the Programme (the International Meteorological Dictionary) was first discussed.

The following Resolution of the Roman Congress was read:—

"The Congress is of opinion that it would be very useful that an international dictionary of meteorology should be published."

The Committee not having received sufficient information upon this scheme, the question was postponed.

Article III. of the Programme (the Conference on Agricultural and Forest Meteorology convened from the 6th of September 1880 at Vienna) was next taken up.

The following Resolution of the Roman Congress was read:—

"In order to contribute to the progress of agricultural and

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forest meteorology the Congress recommends as a programme for study:

"1°. The influence of the meteorological elements upon vegetation.

"2°. The inverse influence of vegetation upon the meteorological elements.

"3°. Agricultural warnings.

"The Congress, finding the subject too important to take a detailed resolution at this meeting, proposes to charge the International Committee with the convening of a special International Conference before next spring, to take into consideration the development of agricultural and forest meteorology."

The Secretary announced that the invitations and programmes for the Conference had been sent to 26 Meteorological Institutes (Appendix IE., p. 25). The countries which had hitherto announced their intention of sending delegates were:—

Bavaria	-	M. Ebermayer.
Belgium	-	M. Chevron.
France	-	MM. Mascart and Grandeau.
Hungary	-	Baron Friesenhof and M. Schenzl.
Switzerland	-	M. Billwiller.

In addition it was announced as probable that Italy would send M. Tacchini, and that Denmark would send Captain Hoffmeyer.

M. NEUMAYER submitted the Report and the Protocols of a private Conference of the heads of the Central Institutes of Germany which had been held at Hamburg from the 2nd to the 4th of April 1880, for the discussion of the questions of the Agricultural Programme.

He announced that probably five or six representatives of Germany would go to Vienna.

Mr. SCOTT informed the Committee that the Meteorological Society of England had nominated a Committee to draw up replies to the questions of the Programme. These replies had been sent directly to Dr. Lorenz von Liburnau at Vienna.

The Committee requested its Secretary to inform Dr. Lorenz of the result of its discussion upon this article of the programme of Rome.

Article IV. of the Programme (the proposed international comparison of Standard Instruments) was then discussed.

The following Resolution of the Roman Congress was read:—

"The Congress recommends the directors of all central institutions to have their instruments compared with the standard instruments of other countries."

The Secretary read the replies which he had received to the Circular (Appendix IA., p. 13), the result of which was that 20 observatories had signified their acceptance of the proposal.

The opinions of the Committee were divided as to the possibility of carrying out at present a satisfactory comparison of Anemometers. It was decided that the number of acceptances was not sufficient to guarantee the realisation of the scheme as it had been formulated in the Circular.

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It was resolved that the question of having standard barometers compared should be referred to a sub-committee composed of MM. Mascart and Mohn.

M. MASCART laid upon the table Vols. 3 and 4 of the "Annales du Bureau Central Météorologique," which had just been published in Paris.

The meeting closed at a quarter-past 12 o'clock.

H. WILD.

Protocol of the Second Meeting, Monday, 9th August, at 5h. 10m. p.m.

All the members of the Committee were present, except M. de Brito-Capello.

The protocol of the first meeting was read and confirmed.

Article XIII. of the Programme (the proposed change of time of the Simultaneous Observation made at the request of the Chief Signal Office, Washington) was discussed.

The PRESIDENT, M. MASCART, and Mr. SCOTT communicated to the Committee a request which had been made by General Myer to them, as well as to the different Directors of the Meteorological Services in Europe, to change the hour of the simultaneous observation from 0h. 43m. to 0h. 8m. Greenwich mean time. M. Rubenson had addressed a letter, dated 6th June, to the President upon the same subject.

The Committee examined the question of the proposed change, and expressed its opinion that, notwithstanding the inconvenience which might be felt by some observers, General Myer's proposal should be adopted.

The meeting closed at 7h. 15m. p.m.

H. WILD.

Protocol of Third Meeting, Tuesday, 10th August, at 10h. 20m. a.m.

All the members of the Committee were present, and also M. WEYPRECHT, by invitation of the Committee.

The protocol of the second meeting was read and confirmed.

M. DE BRITO-CAPELLO assured the Committee that he entirely approved of the resolution taken at last meeting on the question of the simultaneous observation.

Article II. of the Programme (the Polar Conference held in the month of October 1879 at Hamburg, to consider M. Weyprecht's proposal) was discussed.

M. NEUMAYER, President of the International Polar Committee, read the report of that Committee. (Appendix III., p. 27.)

M. CAPELLO submitted to the Committee copies of the magnetical and meteorological results of the Portuguese expedition to Central

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Africa. At the same time he expressed his regret that at present Portugal could not promise to take part in the scheme of the Polar Committee.

After having discussed the proposals of the Polar Committee, the International Meteorological Committee adopted the following Resolution :—

"The Committee has heard the report of the International Polar Committee, and expresses its thanks for this important communication. At the same time it assures the Committee of its support so far as it may be able to render it assistance."

Article XII. of the Programme (M. Köppen's proposal as to the publication of data for rainfall, &c.) was next taken up.

M. KÖPPEN's letter of the 23rd July was read. (Appendix IV., p. 35).

M. HANN informed the Committee that M. Köppen's proposal would soon appear in the *Zeitschrift der oesterreichischen meteorologischen Gesellschaft*, and that he was ready to send to the Committee a sufficient number of copies of this communication, with a resumé in French of the principal points.

The Committee accepted this proposal of M. Hann, and requested the Secretary to distribute the copies of M. Köppen's letter to the principal Meteorological Institutes for the purpose of obtaining opinions upon the proposed change before the next Conference.

The meeting closed at 15 minutes past noon.

H. WILD.

Protocol of the Fourth Meeting, Tuesday, 10th August, 3h. 5m. p.m.

All the Members of the Committee were present; also CAPTAIN HOFFMEYER, by invitation of the Committee.

The protocol of the third meeting was read and confirmed.

The discussion of Article IX. of the Programme (a proposal made by Captain Hoffmeyer respecting an international telegraphic service for the North Atlantic) was commenced. Captain Hoffmeyer's letter of May 11 (Appendix V., p. 37) was read.

After some discussion the Committee adopted the following Resolution :—

"The Committee without examining the practical details of the question, fully agrees with Captain Hoffmeyer, that the establishment of telegraphic communication with the Färoe Isles and Iceland, with Greenland and with the Azores would be of the highest importance for the progress of the science of weather-forecasting in Europe, and expresses its hopes for the realization of the scheme."

The discussion of Article XI. of the Programme (a proposal by Captain Hoffmeyer respecting the publication of means and

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extremes of the meteorological elements for international and telegraphic stations) was then taken up.

Captain Hoffmeyer's letter of the 22nd May (Appendix VI., p. 37) was read.

After some discussion the Committee adopted the following Resolution :—

" The Committee has heard with interest Captain Hoffmeyer's communication, and recommends the Central Institutions to calculate the averages, &c. which he proposes, for the international and telegraphic stations."

Captain HOFFMEYER stated that his Synoptic Charts would be discontinued after those for the month of November 1876 had appeared.

The PRESIDENT expressed, in the name of the Committee, deep regret that these interesting and very useful charts of Captain Hoffmeyer's would cease to appear.

Captain HOFFMEYER hoped that other nations would publish their observations for the Atlantic Ocean as nearly as may be in the same way as M. Neumayer does in his Monthly Summary.

M. NEUMAYER wished, in connexion with Captain Hoffmeyer's statement, to make the following remarks with reference to the proposal which he, conjointly with that gentleman, had made to the Congress at Rome, to the effect that the synoptic charts should be continued and accompanied by a printed text to be issued by both gentlemen under the title of a " Synoptic Weather Review." The proposal had not met with the desired support on the part of the Congress, and on that account had not been carried out by the Deutsche Seewarte or the Danish Institute.

On the other hand daily synoptic charts from the North Atlantic Ocean were prepared from the material collected at the Deutsche Seewarte, and a few specimens were exhibited of these charts, completed by means of the observations from northern stations and the daily charts for Europe and America (and any other available materials).

The charts were drawn not only for 8 a.m. but also for 8 p.m. when necessary, and the Seewarte proposed to publish the results of these investigations in papers to appear in the serial (Aus dem Archiv der Deutschen Seewarte).

Dr. NEUMAYER proceeded to say that the tables of nautical observations from German ships which had hitherto appeared in the " Monatliche Uebersicht der Witterung " would be discontinued unless some reciprocity was shown by other institutes in regard to them. Inasmuch as none of the offices which are in a position to issue such tables have followed the example, it appeared that these tables were not generally considered of great importance, and for that reason the Deutsche Seewarte contemplated the discontinuance of their publication.

Article X. of the Programme (a proposal relative to the exchange of meteorological publications through the post) was next discussed.

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The PRESIDENT drew the attention of the Committee to the great expense and uncertainty, and to the delay caused by the transmission of books, &c. through booksellers, and the Committee considered that it would be better to have recourse to transmission by post as far as possible.

Article XIV. of the Programme (a proposal made by M. Renou for the daily interchange of observations made at various stations) was then taken up.

M. MASCART informed the Committee that M. Renou regularly made chromograph copies of his hourly observations, and he asked whether it would not be possible to make an exchange of such communications between the principal observatories of Europe. This scheme appeared difficult of realization, because it would require a daily tabulation of the self-recording instruments.

The Sub-Committee named at the first meeting (p. 4) to examine Article IV. reported that, after having considered the subject of the international comparison of barometers which had been referred to it, it did not at present see the possibility of effecting this comparison, as had been proposed.

For the general comparison M. HANN thought that in the meantime a mutual comparison of the normal instruments of neighbouring countries might be substituted.

This proposal was adopted.

The meeting closed at 5h. 30m. p.m.

H. WILD

Protocol of the Fifth Meeting, Wednesday 11th August, at 9h. 40m. a.m.

All the members of the Committee were present; also M. Hellman, by invitation of the Committee.

The protocol of the fourth meeting was read and confirmed.

Article V. of the Programme (the proposed general catalogue of the meteorological observations and of the meteorological works and memoirs of all countries) was discussed.

The following Resolution of the Roman Congress was read:—

"The Congress states with pleasure that very valuable preliminary work in the way of catalogues of meteorological observations, memoirs, and works has been already partly executed. But as it is to be desired that these materials should be collected in a general catalogue, the Congress proposes that these publications be divided into two categories:—

"1°. A catalogue of series of observations.

"2°. A catalogue of meteorological works and memoirs.

"As to the first category, the Directors of the different Meteorological systems are invited to prepare catalogues of the published and unpublished observations in their respective countries, and to

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inform the International Committee of the work already done in that direction.

"As to the second category, the Congress is of opinion that the works already done by Professor Cleveland Abbe, and the catalogues already printed of the library of the Meteorological Society of London and of that of the Observatory of Brussels, might well serve as a starting point for more comprehensive publications, and invites all the directors of other meteorological libraries to add the list of works and memoirs which are not yet entered in these catalogues."

M. HELLMANN communicated to the Committee a resumé of his ideas on the scheme for a Catalogue. (Appendix VII., p. 38).

Letters to the Secretary from Mr. Symons, dated 15th July, and from Mr. Ramsay, dated 20th July, were read.

On the proposal of the PRESIDENT, the discussion of the question was divided into two parts:

A. Catalogue of books and articles.

B. Catalogue of observations.

A. *Catalogue of Books.*

M. MASCART announced that the Société Météorologique of France had received a library which was very rich in works on Meteorology, and that it was to be hoped that a general catalogue of French memoirs would be prepared.

Mr. SCOTT announced that he hoped that the Meteorological Council would be disposed to assist in the scheme so far as relates to the Catalogue for the English language.

M. MOHN announced that he was ready to do the same for Norway.

M. HANN announced that he was ready to do the same for Austro-Hungary.

M. BUYS BALLOT announced that he was ready to do the same for Holland.

M. NEUMAYER announced that he was ready to do the same for the Seewarte at Hamburg, by publishing the catalogue of Dove's library.

M. HELLMAN announced that he was ready to do the same for Prussia.

M. CAPELLO announced that he was ready to do the same for Portugal.

M. CANTONI announced that he was ready to do the same for Italy.

The PRESIDENT announced that he was ready to do the same for Russia.

The executive officers of the Committee undertook to communicate this information to the Central Institutions of the countries not represented on the Committee, and to invite them to furnish similar information.

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Upon the invitation of the President, M. Hellmann explained the plan of preparation of the Catalogue which he had elaborated, and stated that—

α. The form of the communications that the Committee desired to receive from the different Institutions was to be found in his letter of the 20th January, Appendix VII. (p. 38).

β. The expense of the preparation of the Catalogue was estimated by him at 520*l.* The cost of printing was estimated at 680*l.* for 1,000 copies.

The question was referred to Mr. Scott and M. Hellman, who were requested to consider the means of carrying out the scheme, and to communicate to the Committee the result of their labours.

B. *Catalogue of Observations.*

The Committee requested the Directors of the Central Institutions to state whether they had complied with the wishes of the Congress at Rome, and again called attention to the interest which such a communication would present.

Agreeably to a proposal made by Mr. Symons the Committee requested the Directors of the Central Institutions to print regularly, in one of their publications, a complete list of the works which had been published by their Institutions.

M. HELLMANN drew the attention of the Committee to the importance of having the acknowledgments of receipt of works, inserted in the publications of Institutions, as far as possible in accordance with bibliographical principles.

Article VI. of the Programme (the proposed international meteorological tables for reduction of observations) was next taken up.

The following Resolutions of the Roman Congress were read:—

"It is desirable that the International Meteorological Committee should undertake the compilation of fresh uniform tables for the reduction of barometric readings to the level of the sea.

"It is equally desirable that the Committee should undertake the preparation of a collection of tables which may be employed in the meteorological systems of the different countries."

The PRESIDENT submitted to the Committee his proposals for the preparation of international tables of reduction, &c. (App. Ic, p. 16).

Mr. SCOTT reported that he had recently learnt that Dr. Guyot had a new edition of his tables nearly ready for publication.

M. MASCART submitted two memoirs by M. Angot on the reduction of the barometer to sea level, and on the determination of heights by means of the barometer, which would appear in the Annales du Bureau Central Météorologique.

M. NEUMAYER submitted a MS. memoir, by M. Köppen, on the reduction of the barometer to sea level.

The PRESIDENT submitted to the Committee proofs of Charts of

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the Isabnormals of Temperature which were to be added to his Atlas of the Temperature of the Russian Empire.

The meeting closed at 15 minutes past noon.

(Signed) H. WILD.

Protocol of the Sixth Meeting, Wednesday, 11th August, at 3h. 15m. p.m.

All the members of the Committee were present.

The protocol of the fifth meeting was read and confirmed.

The discussion of Article VI. of the Programme was continued.

The Committee decided upon undertaking the execution of general Tables of Reduction, and nominated a Sub-Committee to prepare the scheme and to draw up a Report.

This Report to be then distributed among the members of the Committee with the view of obtaining their opinion.

After the Committee has again considered the question, the scheme to be distributed to the different chiefs of meteorological organizations in order to obtain further suggestions.

The Committee requests that the chiefs of meteorological organizations will send to the Secretary copies of the Tables in use in their systems.

M. NEUMAYER reported to the Committee that he was ready to allocate the sum of 20*l.* from the funds of the Seewarte, next year, for the calculation of the tables undertaken by the Committee, on condition that the publication of the work was guaranteed independently of such contribution.

The Committee nominated the President and M. Mascart as members of the Sub-Committee.

Article XV. of the Programme (the discussion of the different resolutions of the Congress of Rome) was then considered.

The several resolutions of the Congress of Rome were read, and the members of the Committee gave information on each of the heads which are printed in Appendix VIII., p. 45.

The meeting closed at 6h. 15m. p.m.

(Signed) H. WILD.

Protocol of the Seventh Meeting, Thursday, 12th August, at 9h. 15m. a.m.

All the members of the Committee were present.

The protocol of the sixth meeting was read and confirmed.

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The Committee decided that the Report of the meeting should be published in the three languages, and requested M. Mascart to undertake the publication of the French edition, M. Neumayer that of the German edition, and Mr. Scott that of the English edition.

The PRESIDENT expressed to Professor Forster, who had been requested by the Committee to be present at this meeting, his hearty thanks for the hospitality which he had kindly shown to the Committee by courteously placing the *Observatoire Tellurique* at their disposal, and at the same time he requested him to convey to the Federal Council of Switzerland, as well as to the authorities of the Canton and City of Berne, their sincere thanks for the cordial welcome with which they had honoured the Committee.

In declaring the Second Meeting of the Committee closed, the President thanked the members for the zeal and preseverance which they had brought to bear upon the deliberations, so tha all the questions of the Programme had been dealt with in a satisfactory manner, and that they would have in any case to record on several points real progress in the accomplishment of the task of the Committee.

M. BUYS BALLOT said he was convinced that all the members would concur in thanking the President for the impartial and liberal manner in which he had directed the discussion at the meetings of the Conference. The Conference had asked for and obtained much interesting information, and had opened up other lines of investigation which would be useful for the advancement of science. The President would be the first to rejoice at this because it was in a great measure due to him that the Conference had obtained these results.

The meeting closed at 9h. 30m. a.m.

(Signed) BUYS BALLOT.
„ G. CANTONI.
„ HANN.
„ E. MASCART.
„ H. MOHN.
„ G. NEUMAYER.
„ J. CAPELLO.
„ R. H. SCOTT.
„ H. WILD.

Berne, 12th August 1880.

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APPENDIX I.

Report of the Secretary to the International Meteorological Committee, 1880.

Gentlemen,

In submitting this the first Report of the International Committee it will be simplest to deal with the various subjects in the order in which they appear in the Programme of the Congress at Rome (Appendix XI. to Report of that Congress).

Article III.—The International Committee has not as yet made any advances towards the preparation of a report on the methods of observations and of publication in different countries, but the Secretary has personally prepared a supplement to Appendix V. of the Roman Report on the Organization of the English System in 1876 (printed Appendix IX. to this Report).

Article V. International Publications.—Dr. Köppen has made a proposal as to the mode of publication of the data relating to rain, snow, &c. in the forms adopted. (App. IV., p. 35.)

Article IX.—As regards the proposed Catalogue of Meteorological Publications, letters from Dr. Hellmann and Mr. Symons, and also from Mr. Ramsay, are submitted to the Committee. (App. VII., p. 38.)

As regards the International Dictionary, the Secretary has not received any fresh communications from M. Pittei.

Article X.—As regards the International Comparison of Standard Instruments, a circular (Appendix Ia, p. 13) has been issued to all the principal observatories. Twenty European observatories have already intimated their readiness to join in the scheme and contribute 360 francs apiece. As to America, Mr. Carpmael, of Toronto, states that he is ready to join if the scheme should be extended to America.

At Yale College an Institute for the comparison of instruments has been organised. The organisation is entirely private like that of Kew, in England. The printed prospectus of the institution is submitted to the Committee.

Article XII. (5)—The Report of the Congress has appeared in three languages. The French edition has been prepared by M. Grassi, the German by Dr. Neumayer, and the English by Mr. Scott.

Article XV.—No information has reached the Secretary as to the preparation of any general reduction tables. A note from the President on this subject is submitted to the Committee. (App. Ic, p. 16.)

Article XXVI. B.—The Secretary has not learned what action has been taken by the Italian Government in regard of Meteorology in Brazil; but a letter from Dr. Walz, of Bogotá, in which he addresses himself to the Committee in order to obtain a grant of instruments and funds for the establishment of a Meteorological station, is submitted.

XXVI. C.—As regards the observations at Trevandrum, the regretted death of Mr. Allan Broun has brought the question of the continuation of the publication of these observations to the notice of scientific men in England and India, and the Secretary can assure the Committee that the subject is now under discussion.

Article XXIX.—The Secretary informs the Committee that General Myer has proposed to change the hour from 0h. 43m. G. M. T. to 0h. 8m. G. M. T. from January 1, 1881. Professor Rubenson refers the subject of the advisability of such a change to the Committee.

Article XXX. A.—The Secretary has the honour to inform the Committee that organised attempts are being made by the Meteorological Council to secure meteorological observations in balloon ascents, thanks to the kind co-operation of the War Office, London.

XXX. B. a & b.—The Secretary has not learnt that anything has been done about publishing mountain observations *in extenso*. It is, however, *hoped* that the Agustia Malley observations (Trevandrum) may be published (see Article XXVI. C.)

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XXX. B. c & d.—The Secretary has not received any definite information as to the proposed mountain stations in Europe, except as to Mont Cimone and Mont Ventoux, about which printed circulars have appeared.

As to M. Hann's proposal relative to the measurement of glaciers, the Secretary is not aware of any results having been published as yet.

The project has been duly communicated to the Alpine Clubs.

Article XXXI.—The Committee may hope to receive from the International Polar Commission a report of their proceedings since the date of the Conference, Hamburg, in October 1879.

Article XXXII. The Secretary has to report the receipt of a letter from Mr. Parkinson, of the Navigators Islands, with reference to his proposal for a meteorological organisation for the Islands of the Pacific Ocean.

He communicates also the printed report of an Inter-Colonial Conference which has been held at Sydney, in November 1879. (App. Id, p. 16.)

C.—As to the proposed stations in distant Islands, the Secretary has no progress to report.

D.—The same is the case as regards the Sclave countries, Bulgaria, Roumania, and Servia, with the single exception of Ibraila, where M. Hepites makes careful observations and distributes copies to the principal institutions of Europe. At the same time it is to be regretted that according to information lately received from M. Schmidt at Athens there is no present prospect of a meteorological organization for Greece.

Article XXXIII.—The Secretary has to inform the Committee that Mr. Sandford Fleming, Chief Engineer of the Central Pacific Railway in Canada, has proposed the meridian of 150° W. of Ferro, which passes through Behrings Straits, as First Meridian, and that this idea has been already supported by several geographers in Europe, particularly by M. Bouthillier de Beaumont, President of the Geographical Society of Geneva.

Article XXXIV.—The Secretary has to report that invitations have been issued to all the countries of Europe to attend the coming Conference on Agricultural and Forest Meteorology in Vienna (App. Ie, p. 25), and that the names of the Meteorologists who propose to attend have been forwarded to Dr. Lorenz von Liburnau.

Finally, the Secretary has to announce the reception of three communications :—

1. From the President : A proposition as to the exchange of meteorological publications by post.

From M. Hoffmeyer : Two propositions :—

1. On the utility of an international intervention in favour of the laying of telegraphic cables to the Azores and Faroes, Iceland, and Greenland. (App. V., p. 37.)

2. On the importance of the calculation and publications of means and extremes for months, and even for five days, for all international and telegraphic stations. (App. VI., p. 37.)

(Signed) Robert H. Scott,
Secretary.

Berne, 9th August, 1880.

APPENDIX Ia.

International Meteorological Committee,

St. Petersburg and London, April 21, 1880.

Sir,

We have the honour to inform you that the International Meteorological Committee has decided to promote at once the comparison of standard instruments, viz. : barometers, thermometers, and anemometers belonging to the Central Institutions recommended by the International Meteorological Congress of Rome.

In accordance with the Report presented by M. Wild to the Congress at Rome upon this subject, the Committee proposes the following plan for carrying out the scheme.

1°. For the comparison of barometers and thermometers the executive officers of the Committee would select a qualified person who should visit the Institutions participating in this undertaking, and verify, by means

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of standard instruments supplied to him for that purpose, the standard barometers and thermometers of those Institutions. For the comparison of the anemometers a standard instrument will be put into circulation.

2°. The Central Physical Observatory of St. Petersburg will lend the standards necessary for this comparison, viz. : *two* first-class barometers, one a siphon, with millimetre scale, and the other a cistern barometer of Fortin's principle graduated in English inches, two thermometers of different constructions, and a standard anemometer on Robinson's system. These instruments will be verified by the standards of the Central Physical Observatory at the commencement and at the end of all the comparisons. In addition, a very careful comparison will be made at the commencement of the journey with the standards of an observatory in Central or Western Europe, to which recourse may be had, in case of accident, without returning to St. Petersburg. If, on the other hand, the standard barometer and thermometer of the International Office of Weights and Measures at Paris should be ready at the time of the comparison, which is very probable, these would serve as a starting point, and the Committee will then purchase the barometers and thermometers used in the comparison, which will be deposited in the office above mentioned after the journey.

3. Detailed rules will be laid down for these comparisons in order to ensure uniformity. These will be communicated to the Institutions participating, as well as to the person who will undertake the journey.

4. Each Central Institution or observatory taking part in this undertaking will pay to the Committee a sum of 360 francs in addition to the cost of the transmission of the anemometer.

5. This scheme will be carried out as soon as 30 Institutions, or less, have agreed to take part in it.

6. The results of the comparisons will be published by the Committee in several periodical journals.

We hope, therefore, that you will be so kind as to inform Mr. R. H. Scott (Meteorological Office, 116, Victoria Street, London) if you intend to take part in this undertaking, for your Institution, on the conditions named, and if so, whether you are ready to pay, upon first demand of the Committee, the proportional quota of 360 francs.

Accept, &c.

H. Wild, President,
R. H. Scott, Secretary,
International Meteorological Committee.

APPENDIX Ib.

St. Petersburg, 9th August, 1879.

At its meeting of the 22nd April 1879, the Second International Meteorological Congress, assembled at Rome, after having deliberated upon Question 31 of its Programme, viz. :

" The Committee after having taken cognizance of the scheme of M. " Weyprecht to establish several observatories in the Arctic and Antarctic " regions so as to organise hourly meteorological and magnetical obser- " vations to be made simultaneously all around the Pole, is of opinion " that these observations will be of the highest importance in developing " meteorology and in extending our knowledge of terrestrial magnetism ; " it thinks, therefore, that in the interest of science, it should recommend " general participation in this enterprise.

" In what manner can the Congress on its part contribute to the success " of the enterprise ? "

made the following resolution upon this question :—

" The Congress recognizes the great importance which should be attri- " buted to synchronous meteorological and magnetical observations made " in the polar regions, by means of simultaneous expeditions, and " it recommends all Governments to give the most effective support " to such undertakings.

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" Considering :

" 1°. That the majority of the members of the Congress are not pro-
" vided with instructions relating to this question.

" 2°. That such instructions are absolutely necessary in order to arrive
" at definite resolutions. The Congress decides to entrust the Inter-
" national Committee with the convening of a special conference which
" should be composed of delegates provided with the necessary instructions
" and powers by their Governments, who may think they could participate
" in some way in the enterprise. By reason of the preparations already
" made by M. Weyprecht and Count Wilczek for an expedition of this
" nature, it thinks it necessary that this Conference should meet at Ham-
" burg, on the 1st October 1879, in order to settle the details of the scheme
" and the means of carrying it out."

Conformably to this resolution, the undersigned, in concurrence with M. Neumayer, a member of the International Committee and Director of the "Deutsche Seewarte," at Hamburg, have the honour to inform you that this Conference will meet at 11h. a.m., on the 1st October, at the "Deutsche Seewarte," Seemanshaus, at Hamburg, and request you to do your utmost to realise the wishes of the International Congress, so that your country may take part in this important undertaking by sending to the Conference a delegate furnished by your Government with the necessary instructions and powers.

In our opinion, the Conference will have especially to take resolutions upon the following points :—

1°. The number of observations and the most suitable localities for establishing them. The decision will depend upon the number of countries co-operating, and on the sums which they will devote to this end.

In a scheme dated 30th September 1877, M. Weyprecht and Count Wilczek have drawn attention to the following localities :—

In the Northern Hemisphere :—

Spitzbergen. Northern Coast.
Nova Zembla. Northern Coast.
Finmark. In the neighbourhood of the North Cape.
Siberia. North Coast, at the mouths of the Lena, New Siberia.
Point Barrow, to the N.E. of Behring's Straits. (Occupied by Maguire from 1852 to 1854.)
Greenland. Western Coast. Danish Settlement.
Greenland. Eastern Coast, about lat. 75°.

In the Southern Hemisphere :—

Cape Horn. Neighbourhood of.
Islands of Kerguelen or Macdonald Islands.
Auckland Islands. One of the Southern groups.

2°. The exact period of the commencement of the observations, and their minimum duration.

3°. Uniform instructions for the observations, which will have especially to determine :—

(*a.*) The minimum of the elements to be observed at each station, both for meteorological and magnetical phenomena, and for other phenomena of the physics of the globe which are allied to them.

(*b.*) The minimum number of observations to be made daily for the different elements.

(*c.*) The first meridian, which shall serve as a basis for simultaneous observations.

(*d.*) The methods of observation and the methods of reduction for the different elements.

(*e.*) The instruments of observation and their erection, in so far as they may have an influence upon the comparability of the results.

We hope therefore that you will be so kind as to inform Mr. Scott (Meteorological Office, 116, Victoria Street, London), before the 15th September, whether your country will send a delegate to the Conference at Hamburg, or not.

Accept, &c.
H. Wild, President, St. Petersburg,
R. H. Scott, Secretary, London,
For the International Meteorological Committee.

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APPENDIX Ic.

International Meteorological Tables of Reduction.

1°. A comparison of the different thermometer scales, Celsius, Fahrenheit, and Reaumur, both for actual readings, and also for differences of temperature, as far as 0°·01.

2°. Tables for the reduction of barometers to 0°c, for English, with inches and Fahrenheit, and for metric, with millimetres and centigrade, to 0·0001 inch and 0·001 mm. for 0°·1 C. Brass scale.

3°. A comparison of English, old French, and metric barometers, as well as Russian.

4°. Tables for the conversion of English inches and tenths, and Paris lines (rainfall, evaporation, &c.) into millimetres and *vice versâ*.

5°. Tables of the tension of aqueous-vapour.

6°. A table of constants for the dry and wet bulb thermometer readings.

7°. A table for the correction for Gravity.

8°. Tables for the reduction of barometer readings to sea-level.

9°. Tables for the reduction of temperatures to sea-level.

10°. A comparison of wind velocities in kilometres per hour and English miles per hour with metres per second.

11°. Tables for the calculation of height above sea from the readings of the barometer. Tables?

12. Tables for the conversion of heights in English feet and old French feet into metres and *vice versâ?*

13°. Other tables as at the end of Guyot?

The tables are to be according to accurate formulæ and with the most recent constants, calculated to one decimal more than necessary, in order to serve as a basis for less accurate tables in all countries.

The publication to be undertaken by a bookseller. The Committee simply to collect the requisite number of subscriptions, at a fixed price, for the publisher.

H. Wild.

APPENDIX Id

Minutes of Proceedings of the Intercolonial Meteorological Conference, held at Sydney on the 11th, 13th, 14th November 1879.

Tuesday, 11th November 1879.

The Conference met at the Sydney Observatory, at 10 a.m.

Present:

James Hector, Esq., M.D., C.M.G., F.R.S., Inspector of Meteorological Stations, New Zealand; C. Todd, Esq., C.M.G., F.R.A.S., Government Astronomer, South Australia; R. L. J. Ellery, Esq., F.R.S., Government Astronomer, Victoria; H. C. Russell, Esq., B.A., F.R.A.S., Government Astronomer, New South Wales.

H. C. Russell, Esq., was called to the chair.

The Chairman read the following letter:—

Colonial Secretary's Office, Sydney,
8th November 1879.

Sir,

I am directed by the Colonial Secretary at the instance of the Minister of Justice and Public Instruction, to transmit herewith copies of propositions for the consideration of the scientific men nominated by the

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several Australian Colonies to consider what means should be adopted to improve the system of intercolonial weather signals.

I have, &c.
CRITCHETT WALKER.

To the Chairman of the meeting of scientific men appointed to consider what means should be adopted to improve the system of intercolonial weather signals.

PROPOSITIONS FOR METEOROLOGICAL CONFERENCE.

1. To consider the meteorology of Australia and New Zealand, with a view to united action in its investigation.
2. To consider whether additional first-class stations shall be established, and if so, in what localities.
3. To consider the desirability of using the same class of instruments at all stations and making the observations at the same local hour.
4. To consider the desirability of securing the co-operation of the meteorologists of New Zealand and Tasmania in the system of weather telegrams, which now embraces the Colonies of South Australia, Victoria, New South Wales, and Queensland.
5. To consider by what means the weather telegrams may be transmitted and published for public information at an earlier hour than they are at present.
6. To consider whether meteorological stations should be established upon the highest available mountains for the special study of winds.

Observatory, 27th October 1879. H. C. RUSSELL.

He said the object for which the Conference had met was to devise some system by means of which more united action might be established in respect to meteorological observations, and especially with regard to weather telegrams. He had experienced great difficulty in obtaining telegrams from the different Colonies with sufficient punctuality, and he thought that if the matter were discussed in Conference some suggestions would be made by which the transmission of these telegrams might be greatly facilitated, and earlier information furnished to the public. Holding this opinion, he had suggested the desirability of having a Meteorological Conference, and the Government of New South Wales had sent invitations to the Colonies of South Australia, Victoria, Queensland, Tasmania, and New Zealand. Queensland and Tasmania had not responded to the invitation, or at least they had not sent representatives. He very much regretted the absence of the representatives of the Colonies of Queensland and Tasmania, but thought the Conference should proceed with the business before them.

UNITED INVESTIGATION OF METEOROLOGY.

To consider the meteorology of Australia and New Zealand, with a view to united action in its investigation.

Mr. Ellery thought it would be well to start by affirming the desirableness of united action, and he would therefore move formally, before entering upon other questions, the following resolution in reference to the first proposition :—

That in view of the great importance which a better knowledge of the movement and origin of strong gales and storms on our coast lines and neighbouring seas is to the shipping and commercial interest generally, it is desirable to secure, as far as possible, co-operation in all the Australasian Colonies for the investigation of storms, as well as for agricultural and general climatological purposes.

It had already been shown that the westerly gales which visit New Zealand and the easterly gales occurring on the coast of Australia were marked by premonitory signs ; and some co-operative action in the transmission of information could not fail to lead to profitable results.

The resolution, after discussion, was agreed to.

Dr. Hector moved :—

That with the view of giving effect to the foregoing resolution, similar

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observations and the same form of publication should, as far as possible, be adopted throughout the Colonies.

He explained that he did not mean that no other form of observations should be published, but that the Government of each Colony should be asked to sanction the expense of publishing certain observations taken at the same local hour in the form required by the Conference, so that they could be compared with each other.

The resolution, after discussion, was agreed to.

First-class Stations.

The Chairman read the second proposition :—

To consider whether additional first-class stations shall be established; and if so, in what localities.

He thought the Conference should free themselves from the task of defining what constituted a first-class station, as circumstances might arise to alter their opinion on that point.

Mr. Todd : There would in reality be only one first-class station in each Colony, which would be the Observatory.

Mr. Ellery did not think it would be desirable to lay down any fixed rule on this point. The different Colonies worked under different circumstances, and all that was required was to secure their co-operation.

Dr. Hector thought the number and position of the different stations should be left for each Colony to determine. The Conference should not dictate to the Colonies what expenditure they should incur; nor did he think they should lay down any expensive or elaborate scheme which might have the effect of preventing cordial co-operation.

The chairman said his object in submitting this proposition was to suggest one or two more stations in the western district. It would be seen in the map that there was a scarcity of stations in the interior; and as most of the atmospheric disturbances came from the west, the establishment of additional stations there would supply valuable information.

Mr. Todd moved :—

That in order effectively to carry out the objects of the Conference as affirmed in the foregoing resolution, it is desirable to establish first-class meteorological stations in certain well-selected positions in the several Australasian Colonies, including New Zealand, in addition to those now existing.

The resolution, after further discussion, was agreed to.

On the motion of Dr. Hector, the Conference adopted the definition of the work of a first-class station given in the preface to the New Zealand Meteorological Report for 1873.

"The observations taken are limited to those for determining atmospheric pressure; maximum and minimum daily teperature of atmosphere, and of insulation and radiation; the average daily amount of moisture, the rainfall and number of rainy days; the force and direction of wind, and amount and character of cloud."

Similar Instruments.

Third proposition :—

To consider the desirableness of using the same class of instruments at all stations, and making the observations at the same local hour.

The Chairman said he was aware that in some cases instruments of different kinds were used, and thus the results were not comparable. He did not think temperature observations could be exact at all stations—a different way of exposing the thermometers made such a difference in the result. With regard to the barometer, it would be sufficient to say that it should be a mercurial barometer and not an aneroid; and with respect to the wet and dry bulb, it should mean an instrument of good class, certified to by a firm of recognized position, and the same with regard to the maximum and minimum thermometers; and the rain-gauges should be used at the same altitude from the ground.

Mr. Ellery moved :—

That the instruments at each first-class station consist of a mercurial barometer of either the Standard or Board of Trade form; thermometers

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of Kew, or approved, patterns, compared with standards as frequently as possible; rain-gauges of 8 inches collecting diameter; and wind-gauges of any approved form. The local hours of observation to be 9 a.m., 3 p.m., and 9 p.m. Beaufort's scale of wind to be adopted; the observations to be recorded in equivalents in velocity and pressure.

The resolution, after discussion, was agreed to.

Desirability of Co-operation.

Fourth proposition :—

To consider the desirableness of securing the co-operation of the Governments of New Zealand and Tasmania in the system of weather telegrams, which now embraces the Colonies of South Australia, Victoria, New South Wales, and Queensland.

Mr. Ellery said, with regard to Tasmania, that for the meteorological knowledge of that Colony they were indebted to the long and valuable gratuitous services of F. Abbott, Esquire, of Hobart Town. But in order to provide for carrying out the proposed scheme, which involved a daily expenditure for telegrams, he would move: That it is very desirable to obtain the co-operation of the Government of Tasmania, and to persuade them to establish a station at the public expense at Hobart Town. He did not think this would be a difficult matter if the Conference suggested it. At present there was no machinery to co-operate with, and it was very desirable that one or two first-class stations should be established. He thought it would be better not to take Launceston for a second station, which was a long way inland, but rather to take George Town.

The resolution, after discussion, was agreed to.

Dr. Hector moved :

That it is desirable to secure the co-operation of the Governments of Western Australia, New Zealand, and Tasmania, in the system of weather telegrams, which now embraces the Colonies of South Australia, Victoria, New South Wales, and Queensland.

With regard to New Zealand, on account of the greater expense of communication, the great range of latitude, and the consequent complicated phases of weather which occurred simultaneously in the different coastal areas, it was desirable that instead of any different observations or reading of instruments being transmitted, a daily synoptical report of the general conditions of the weather should be prepared at the Head Office in New Zealand and transmitted, together with immediate telegraphic notice of any important or exceptional phenomenon; and that the return communications to New Zealand should be comprised in a similar synoptical report of the state of the weather in the different coastal areas of Australia, to be prepared and transmitted from the Observatory in Sydney.

The resolution, after discussion, was agreed to.

Mr. Ellery moved :—

That, in the opinion of this Conference, it is desirable that weather telegrams and forecasts shall in all cases depend upon the observations used for general meteorological and climatological statistics, and be under the direction of the head of the meteorological department in each Colony.

Mr. Todd thought such a resolution was essential to prevent conflicting reports and to ensure public confidence.

The resolution, after discussion, was agreed to.

The Conference adjourned at 1 p.m., until Thursday, 13th instant, at 10 a.m.

Thursday, 13th November 1879.

The Conference met at the Observatory at 10 a.m.

Present :

Dr. Hector, Mr. Ellery, Mr. Russell, Mr. Todd.

H. C. Russell, Esq., in the Chair.

The minutes of the previous meeting were read and confirmed.

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The Conference resumed their consideration of the 4th proposition, affirming the desirableness of securing the co-operation of the New Zealand and Tasmanian Governments in the system of weather telegrams.

Mr. Todd moved:—

That this Conference, having been informed that the Eastern Extension Telegraph Company will charge half rates for the transmission of weather reports through the cable connecting Australia and Tasmania, and probably also the cable to New Zealand, recommend that the cost of such reports be defrayed by the participating Colonies in equal proportions; and that in the opinion of this Conference, such cost need not exceed in the aggregate 350*l.* per annum.

2. That, in the opinion of the Conference, this expenditure is justified by the extreme importance to the shipping interest of early information of the approach of dangerous easterly and westerly gales.

He said that as these reports transmitted through the cable would be merely synoptical reports of the state of the weather in Australia on the one hand, and in New Zealand and Tasmania on the other, they need not be of great length. Messages comprising ten or twelve words would probably, by means of the code adopted, convey all the information that would be required. A message of ten words would cost—to or from New Zealand—at the reduced rate, about five shillings. The amount named in the resolution would therefore, in his opinion, be ample.

The Chairman said, that from the experience in reference to gales which he had obtained during a number of years, it was quite evident that from the observations taken in New Zealand and the southern Colonies valuable warnings might be given. A short warning of the approach of a gale in many instances would be the means of saving a large amount of property, as the vessels could take refuge in the coast harbours. Warnings of dangerous gales might be given several days in advance, and considerable importance was attached to such information by the shipping interest. For instance, in the severe gale in which the "Dandenong" was wrecked, it had subsequently appeared that valuable information might have been given sufficiently in advance to prevent the great loss of property which took place, if that information could have been furnished to the shipping interest at the different ports along the coast.

Mr. Todd entirely concurred with the Chairman as to the importance and value of this information, and especially of the reports from western stations. His observations tended to show a great regularity in the easterly march of disturbances from the westward, and the stations in South Australia, and especially in Western Australia, should be able to give the easterly Colonies timely warning of approaching gales, because they would be able to report the effect of a gale which had already reached one of these stations. The information would therefore not be hypothetical, but an actual fact of which timely notice could be given.

Dr. Hector said that from a New Zealand point of view, he thought it would be very advantageous that Queensland should join in this co-operation, as it would be from that quarter they would receive early notice of the origin and progress of the dangerous and suddenly occurring cyclones that crossed the northern part of New Zealand. On the other hand, the southerly gales could not, of course, be directly predicted in Australia for New Zealand, but New Zealand could give early information to Australia of the occurrence of such gales, and probably Queensland would receive the greatest benefit from such predictions.

Mr. Ellery said that in that view of the case, great advantage would be derived from the establishment of a station at Hobart Town, because if Hobart Town observations were discussed in connexion with this movement on the western coast of Australia and the subsequent weather on the east coast, it would be found that those observations would often determine whether that easterly movement had been deflected by any other current. The observations at Hobart Town would indicate a considerable time beforehand whether the disturbance would become a serious one on the eastern coast of Australia. For instance, it was a fact that the gale in which the "Dandenong" was wrecked was indicated at Hobart Town thirty hours before it reached Sydney.

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Mr. Todd called the attention of the Conference to the hurricane which struck the Lacepede Islands and the north-west coast of Australia on the 24th and 25th of December, 1878, as a case in point. The barometer fell to 29·50 and 28·94; at Alice Springs, in the centre of the continent, it began to fall on the 30th, reaching 29·6 on the morning of January 2nd; at Eucla, the barometer fell from 30·2 on December 29th, to 29·50 on January 1st; at Cape Borda, it fell from 30·23 on December 30th, to 29·53 at midnight on January 1st; at Cape Northumberland, it fell from 30·2 on the morning of 30th December, to 29·35 at 6 p.m on January 2nd, or six hours after Cape Borda; and the barometer fell to 29·30 at Hobart Town in the afternoon of January 2nd, or about 24 hours after passing the Great Bight. The storm between the Great Bight and Hobart Town was probably identical with, or the subsequent effect of, the hurricane on the north-west coast, in which case it must have had a slow progressive motion over the Australian continent, between the north-west coast and the Australian Bight, emerging from the coast at about the Great Bight, and occupying 24 hours in passing from the Great Bight to Hobart Town.

The resolution was then agreed to.

Weather Telegrams.

5th proposition:—

To consider by what means the weather telegrams may be transmitted and published for public information at an earlier hour than they are at present.

The Chairman said the idea which was present to his mind in submitting this proposition was to suggest that weather telegrams should, in Australasia, as in Europe, take precedence of all other telegrams. This arrangement would not add in any appreciable respect to the time occupied in transmission, and the delay of five or six minutes caused by sending these messages first could not be any serious detriment to business. He thought it probable that if the matter were represented by the Conference to the several Governments, the general principle would be adopted, and weather telegrams would take precedence of all other messages, Government telegrams of course excepted.

Mr. Todd entirely concurred with the Chairman in thinking it highly desirable that weather telegrams should have the precedence, and he saw no practical difficulty in giving effect to the resolution. No doubt the hour which had been agreed to—9 o'clock—might appear at first sight to clash with the ordinary routine business at the telegraph offices; but as a matter of fact, with the exception of the transmission of messages from the different stations to the central office at 9 o'clock, there would be no reports sent at that hour. It would probably be 11 o'clock before all these messages would be received at the central office. In his case it was generally a quarter-past 10 before he could send any weather reports to the other Colonies. In the case of Western Australia it was still later, on account of the difference in longitude. So that the sending of these weather reports would not really clash with the Office reports, and there was no reason why they should not be transmitted immediately, and take precedence of all private messages. He thought it only required to be properly represented to the different Governments, so that the telegraphic departments might be instructed that the weather reports were to take precedence, and the telegraph superintendents in the different Colonies would be relieved from any responsibility in the matter. It should be borne in mind that by the adoption of the cypher code, the messages were reduced to the minimum in point of length.

He would now move—

That the several Governments be requested to cause precedence to be given to the regular weather telegrams and special storm reports.

Dr. Hector said, that in New Zealand they had three kinds of telegrams—"urgent," "ordinary," and "delayed." The public could take advantage of this scale, and by paying two shillings could make a telegram urgent. Messages arriving in the evening could be sent as delayed telegrams in time for the morning post.

Mr. Ellery said the value of weather information was lost in many cases by delay, while it was increased in proportion to the punctuality with

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which it was furnished. He might state that in his last Annual Report he had made reference to the procedure in America and several European States who had at first to be coaxed into allowing weather telegrams to take precedence, but they now generally accorded it. Weather telegrams were of no value to the shipping and commercial interest unless they were transmitted punctually. In Victoria the Chief Secretary had entered into correspondence with the Telegraph Department of that Colony on the subject, and precedence had always been accorded. He thought it would only be necessary to bring the matter before the several Colonial Governments. The only difficulty would lie with the Telegraph Departments themselves.

The resolution was agreed to.

MOUNTAIN STATIONS.

6th proposition :—

To consider whether the meteorological stations should be established upon the highest available mountains, for the special study of winds.

The Chairman said, his object in putting this proposition before the Conference was to obtain if possible records of the winds that passed overhead, and were therefore lost to the records of the lower stations.

From observations made years ago by Strzelecki, it appeared that at the top of Mount Wellington he had noticed a hot wind which was not felt at all 3,000 feet lower on the same mountain ; and from similar observations in this Colony it appeared that hot winds were frequently felt at the high stations and not at those which are at a lower level.

Similar facts might be stated with regard to the south-east gales, which frequently appeared first at lofty stations. He thought these facts were a sufficient reason for the establishment of stations on high mountain peaks,—the only means which appeared to him available to secure the desired information.

Mr. Ellery moved :—

That, in the opinion of this Conference, there should be established in each of the Colonies, upon a high mountain peak, a meteorological observatory for the special study of winds and other meteorological phenomena :

And that the most desirable positions for them would be the following :—

	About
South Australia—Mount Lofty -	2,500 feet above sea level.
New South Wales—Kiandra - -	4,600 ,,
New Zealand—Tauhara Taupo -	4,600 ,,
Do. Mount Herbert -	4,000 ,,
Tasmania—Mount Wellington -	4,000 ,,
Victoria—Mount Macedon - -	3,500 ,,

The resolution, after discussion, was agreed to.

The Conference adjourned at 1.15 p.m., until to-morrow, Friday, 14th instant, at 9 o'clock a.m.

Friday, 14th November 1879.

The Conference met at the Observatory, at 9 a.m.

PRESENT :

Dr. HECTOR, Mr. ELLERY, Mr. RUSSELL, Mr. TODD.

H. C. RUSSELL, Esq., in the Chair.

The minutes of the previous meeting were read and confirmed.

Mr. Todd moved :—

That the revision of the present telegraph weather code be referred to Messrs. Russell and Ellery, with a view to its simplification and extension.

The resolution, after discussion, was agreed to.

Dr. Hector moved :—

That the interchange of weather statistics, in carrying out the suggestions of this Conference, between the different Australasian stations should be in the form of a diagram, and that this should not interfere

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with the printing of statistics by the different Colonies in any way they like.

He would at the same time strongly recommend that some uniform system of publication should be gradually approximated.

The resolution, after discussion, was agreed to.

Mr. Ellery moved :—

1. That the monthly graphic records for interchange consist of curves, showing—

Barometer,
Velocity and direction of wind,
Temperature,
Humidity,
Rainfall,

with remarks upon weather, especially with reference to storms and atmospheric disturbances, and that specific forms be prepared and distributed to the co-operating Colonies.

2. That the mean humidity curve be derived from the means of maximum and minimum of wet and dry bulb thermometers.

3. The barometer curve to be constructed from barographic records, so as to depict the turning points.

4. The temperature curve to represent maximum and minimum and mean for each day.

5. The velocity and direction of the wind to be deduced from the anemometer.

The resolution was, after discussion, agreed to.

Dr. Hector moved :—

That, in the transmission of cablegrams, the reports be generalized from the local weather reports.

For New Zealand the following subdivision into districts is recommended for convenience of reporting :—

A. - -	N.E aspect - -	North Cape to East Cape.
B. - -	N.W. aspect - -	Cape Maria to West Cape (exclusive of Cook Straits).
C. - -	S. aspect - -	West Cape to Moeraki.
D. - -	S.E. aspect - -	Moeraki to East Cape (exclusive of Cook Straits).
E. - -	Cook Straits - -	Comprising Wanganui, Wellington, Cape Campbell, and Cape Farewell, Nelson.

A code to be framed to express the weather in each of the above aspects in general terms, according to the judgment of the reporter, thus—

Aspect.	Wind and Weather.	Rain.	Sea.

No remark to indicate absence of marked phenomena.

The resolution, after discussion, was agreed to.

Mr. Ellery moved :—

That the cablegrams furnished to Melbourne by Tasmania should conform with those between the Australian Colonies.

The resolution was, after discussion, agreed to.

Mr. Todd moved :—

1. That weather telegrams from the Australian Colonies shall comprise—

(1.) Barometer reduced to 32° and sea level,
(2.) Dry bulb,
(3.) Humidity,
(4.) Maximum and minimum,
(5.) Direction and velocity of wind,
(6.) State of weather,
(7.) Rainfall,
(8.) Sea disturbances,

with a synoptical report of the weather generally.

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2. And that within New Zealand the same system should be adopted.
The resolution, after discussion, was agreed to.
Mr. Ellery moved :—

That the extreme importance of the weather system proposed be strongly urged upon the Queensland Government, with a view to obtain their more active co-operation.
The resolution was, after discussion, agreed to.
It was further resolved,—

That Australia be divided into six meteorological areas for transmission of reports to New Zealand, viz., Western Australia, South Australia, Victoria, New South Wales, and Queensland, South Australia being divided into two districts, tropical and extra-tropical.
The Conference adjourned at 11.80 a.m., until half-past 7 o'clock the same day.

The Conference met again at 7.30 p.m.

PRESENT :

Dr. HECTOR, Mr. ELLERY, Mr. TODD, Mr. RUSSELL.

H. C. RUSSELL, Esq., in the Chair.

The minutes of the previous meeting were read and confirmed.
It was resolved,—

That weather telegrams be written on paper of a special colour, so as to be readily distinguishable in the offices.
Mr. Todd moved :—

1.. That the solar radiation thermometers should be blackened bulb thermometers in vacuo, and should be exposed on an open space at an elevation of 4 feet 6 inches from the surface of the ground, supported by a post carrying two light arms.

2. And that radiation thermometers be placed over grass.
The resolution, after discussion, was agreed to.
Mr. Ellery moved :—

That the following subjects for experiment be referred to each member of the Conference, for future consideration and report :—

1. Shade temperature.
2. Swinging thermometer and thermometer sheds in use.
3. Standards to be swung with 2 ft. 6 in. string during sunshine and after sunset.
4. Observations to determine the difference in humidity by self-registering maximum and minimum thermometers, and by other methods.
5. The best method of measuring the velocity and pressure of wind.
6. Whether any better method than black bulb thermometers can be devised for measuring the direct effect of the sun.
7. As to the best method of determining spontaneous evaporation.

The resolution was discussed and agreed to.
Mr. Ellery moved :—

That as investigation of the Newcastle tide-gauges has shown that such instruments give valuable indications of distant earthquakes, gales, and sea disturbances, it is desirable, in the opinion of the Conference, that self-registering tide-gauges be established in as many convenient places as possible on the coast, in connection with the Meteorological Departments of the different Colonies.
The resolution was agreed to, after discussion.
Dr. Hector moved :—

That the foregoing minutes be adopted as the report of this Conference on the various matters referred to it, and that the Chairman be requested to report to the Government of New South Wales.

H. C. RUSSELL.
ROBT. J. ELLERY.
CHARLES TODD.
JAMES HECTOR.

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APPENDIX Ie.

International Meteorological Committee,
St. Petersburg and London, 8th April 1880.

CONFERENCE FOR AGRICULTURAL AND FOREST METEOROLOGY.

At its meeting of the 22nd April 1879, the second International Meteorological Congress assembled at Rome, after having deliberated upon Question 35 of its Programme, viz. :—

"How can the development of meteorology in connexion with agriculture and forestry be forwarded by the Congress?"

passed the following resolution :—

"In order to contribute to the progress of agricultural and forest meteorology, the Congress recommends as a programme for study :—

"1°. The influence of the meteorological elements upon vegetation.

"2°. The inverse influence of vegetation upon the meteorological elements.

"3°. Agricultural warnings.

"The Congress finding the subject too important to take a detailed resolution at this meeting, proposes to charge the International Committee with the convening of a special International Conference before next spring, to take into consideration the development of agricultural and forest meteorology."

Agreeably to this resolution, the undersigned, in concurrence with Dr. Lorenz von Liburnau, Chief of the service of Forest Meteorology in Austria, have the honour to inform you that such a Conference will meet on the 6th September, at 11h. a.m., in the building of the Academy of Sciences at Vienna, and will last, probably, five days. The members of the Conference are also invited to take part in a preliminary meeting on the 5th September, at 5h. p.m., in order to settle the Agenda for the general meeting of the following day.

In inviting you to be good enough to take part in this Conference, either personally, or by sending another competent person who will be able to represent your Institution, we request you to inform, as soon as possible, Mr. R. H. Scott (Meteorological Office, 116, Victoria Street, London) of the name of the gentleman who will participate on your part at the Conference of Vienna.

We annex for your information a preliminary programme of the questions to be discussed by the Conference.

Accept, &c.
H. WILD, President.
R. H. SCOTT, Secretary.

For the International Meteorological Committee.

N.B.—Agreeably to the desire expressed by the Congress, the Conference was fixed by the first invitation issued by one of us for the 18th May, but has had to be postponed until the date stated above, for reasons independent of M. Lorenz and at the desire of many persons interested.

PROGRAMME of the CONFERENCE at VIENNA for the DEVELOPMENT of AGRICULTURAL and FOREST METEOROLOGY.

The object of the Conference for Agricultural and Forest Meteorology is not only to instigate new methods and investigations in this special branch of Meteorology, but also to determine, with greater accuracy than at present exists, the part which existing central meteorological offices, with their systems of ordinary stations, can take in the development of this brach of meteorology by their observations and investigations, and also to consider the ways and means of organising this participation in the best manner. Accordingly the proceedings of the Conference are to be especially concentrated upon the following points :—

I. What are the mutual relations between the meteorological elements and vegetation, not only those already investigated, but those theoretically supposed to exist.

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II. To what observations of meteorological elements is particular attention to be paid, with special reference to their influence on vegetation?

III. To what extent and how, can meteorological observatories and stations include such observations in the sphere of their operations, without hindrance to their activity in other directions?

IV. Would it not be desirable, with a view to special observations which must be undertaken, as 'e.g.' phenological observations, to prepare a general form of Instructions?

V. Can Meteorological Institutes at present issue weather forecasts for the use of agriculturalists with any prospect of success? And if the answer should be in the affirmative, how should the service be organized so as to attain this object as fully as possible?

Preliminary materials for the answers to these questions will be found in the Reports of Dr. Lorenz von Liburnau, and of Dr. C. Bruhns, to the Second International Meteorological Congress at Rome, on Article 35 of its Programme. These reports have been published separately in German, and also, in abstract, in French in the collection of all the reports to that Congress issued by the Central Meteorological Office at Rome. In the same collection a report of M. le Père F. Denza on this question is printed.

APPENDIX II.

INTERNATIONAL METEOROLOGICAL COMMITTEE.

SIR, St. Petersburg and London, 28th May 1880.

CONFORMABLY to the instructions of the International Meteorological Congress at Rome, we have the honour to inform you that the International Meteorological Committee appointed by that Congress will meet for a first session on the 9th August 1880, at Berne (Switzerland), and that, up to the present time, the following subjects have presented themselves for discussion at this meeting:—

1°. The Report of the Secretary on the action of the Committee since the Congress at Rome.

2°. The Polar Conference held in the month of October 1879 at Hamburg.

3°. The Conference for Agricultural Meteorology, convened for the 6th September 1880 at Vienna.

4°. The proposed comparison of the standard instruments of the observatories in Europe.

5°. A general catalogue of the meteorological observations and of the meteorological works and memoirs of all countries.

6°. International meteorological tables for the reduction of observations.

7°. The international meteorological dictionary.

9°. A Supplement to Appendix V. of the Report of the Congress at Rome concerning the organization of the Meteorological Service in England in 1876, by Mr. Scott.

9°. A proposal made to the Committee by Captain Hoffmeyer respecting an international telegraphic service for the North Atlantic.

10°. A proposal relative to the exchange of meteorological publications through the post.

In case you should desire to present to the Committee any proposal, or any remarks upon any of the questions, you are requested to be good enough to forward them in time to Mr. R. H. Scott (Meteorological Office, 116, Victoria Street, London).

Accept, &c.

H. WILD, President.
R. H. SCOTT, Secretary.
For the International Meteorological Committee.

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Questions added subsequently :—

11°. A proposal by Captain Hoffmeyer respecting the publication of the means and extremes of the meteorological elements for international and telegraphic stations.

12°. A proposal by M. Köppen as to the publication of data for rainfall, &c.

13°. M. Rubenson's letter respecting the change of the time of the simultaneous observations proposed by General Myer.

14°. The daily interchange of observations made at various stations, proposed by M. E. Renou.

15°. A discussion of the different resolutions of the Congress of Rome.

APPENDIX III.

Berne, 10th August 1880.

I HAVE the honour to submit to the International Meteorological Committee the accompanying copy of the protocol of the proceedings of the second Polar Conference, which was held here from the 7th to the 9th instant.

When I sent the subjoined protocols and a summarised report of the proceedings of the first International Polar Conference to the President of the International Committee on the 13th January last, I took the opportunity to request, in the name of the International Polar Commission, the assistance of the Committee in carrying out the decisions of the former Conference. And again to-day I address this request to the Committee, in the name of the Polar Commission, pointing out specially, at the same time, that it will be of extreme importance to obtain the participation of the countries not represented at the two Conferences in the plan of Polar research, and also to ensure the support of the Committee therein.

As will be seen from the protocols, a report of the recent Conference will be drawn up and published, to which a lithographed copy of the accompanying protocols will be appended. This can, of course, only be done after the lapse of some weeks, while it is the decided wish of the Conference that the matters discussed by it may be discussed at this meeting of the International Meteorological Committee. Under these circumstances, I can only hand in a copy of the protocols, to which I add a resumé of the most important results of the Conference.

The results may be stated as follows —

1°. Although the question of participation in the plan of Polar research has only been accepted in a definite form by a few countries, it may, however, be affirmed that the sympathy with the scheme and the probability of a sufficient participation for the carrying out of the same have made considerable progress during the ten months which have elapsed since the Hamburg Conference.

2°. The second Polar Conference adheres almost entirely to the decisions taken at Hamburg, both as regards the general principles and also the details for carrying out the great plan.

3°. The impossibility of preparing the preliminary arrangements for the individual expeditions within the space of time fixed by Paragraph 13 of the first Report, has induced the Conference to decide that the execution of the whole plan shall be deferred for a year, and fixed for the autumn of 1882-3.

In conclusion I have the honour to inform the Committee that from many considerations, partially expressed in the protocols, I have decided to resign my office of President. In my place, Prof. Wild, as President of the International Meteorological Committee, who was elected a member of the Polar Commission in the preceding meeting, was unanimously chosen at the meeting of the 9th August as President of the Commission.

G. NEUMAYER.

To the International Meteorological
Committee, Berne.

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REPORT of the DISCUSSIONS and RESOLUTIONS of the INTERNATIONAL POLAR CONFERENCE held at HAMBURG from the 1st to the 5th October 1879.

THE second International Meteorological Congress, which assembled at Rome in the month of April of that year (1879), at its meeting of the 21st April, by a resolution, and in compliance with a proposal made by the 5th Sub-Committee, charged the International Meteorological Committee with the convening of a special Conference at Hamburg on the 1st October, of that year, to consider the scheme of MM. Wilczek and Weyprecht, for a systematic and scientific exploration of the Polar regions.

In pursuance of this charge, the executive officers of the Committee addressed, on the 9th August of that year, an invitation (contained in Appendix I.) to all the former members of the Congress and to a number of public and private scientific institutions.

This invitation requested participation in the Conference, and requested at the same time all those who intended to take part in it to inform Mr. R. H. Scott, Secretary of the International Committee, or Dr. Neumayer, Director of the Deutsche Seewarte, thereof. The latter gentleman undertook the necessary arrangements for the Conference. In accordance with the wish expressed in the above-mentioned resolution of the Meteorological Congress, a note was added to the invitation, requesting the members of the Conference to provide themselves with instructions from their respective Governments or Societies. The object of this note was to facilitate discussion, and especially to call together only such delegates that might have powers from their respective authorities of promising, in some way or other, an efficient participation in the undertaking to be promoted by the Conference.

In consequence of this invitation, but also of the restriction contained in the note referred to, a number of replies arrived at the end of last September (1879), of which eight or ten only gave a prospect of participation.

On the 1st October, at 11h. a.m., conformably to the invitation, the members whose names follow in alphabetical order assembled at the Conference in the building of the Deutsche Seewarte.

1°. Professor Buys Ballot of Utrecht, delegate of the Ministry "Waterstaat Handel-en Nyverheid," for Holland.

2°. Captain Hoffmeyer, of Copenhagen, delegate of the Royal Ministry of Marine, for Denmark.

3°. Professor Lenz, delegate of the Imperial Geographical Society of St. Petersburg.

4°. Professor Mascart, of Paris, delegate of the Ministry of Public Instruction of France.

5°. Professor Mohn, of Christiana, delegate of the Royal Norwegian Ministry of Instruction, for Norway.

6°. Professor Neumayer, Hamburg, and

7°. Captain von Schleinitz, of Berlin, delegates of the Imperial German Admiralty, for Germany.

8°. Lieutenant Weyprecht, of Trieste, for Austria, with full powers from the Imperial Ministry of Instruction to take part in the meetings, and as delegate of his Excellency Count H. Wilczek.

9°. Dr. Wykander, of Lund, delegate of the Royal Academy of Sciences of Stockholm, for Sweden.

M. Neumayer welcomed the meeting in a short speech, in which he explained the importance of the Conference for the advancement of the physical sciences; he expressed the hope that the discussions which were about to take place would produce satisfactory results for the carrying out of the undertaking in question, and at the same time recapitulated the history of the origin of this Conference. He then read the letters which he had received, respecting the participation or non-participation in the Conference. Among the latter the following are quoted in the Appendix to this Report, under Nos. 2, 3, and 4, because they give reason to hope for an eventual co-operation in the proposed undertaking; these are:—

A letter from General Myer to M. Weyprecht.

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A letter from Mr. Kingston of Canada, to Mr. Scott.
A letter from Commander Cheyne to Mr. Scott.

After these preliminary and purely routine details, M. Neumayer proposed to the members to constitute the executive officers of the Conference by the election of a President and Secretary. This proposal was adopted, and M. Neumayer was elected President, and M. Hoffmeyer, Secretary. After its constitution, the Conference commenced its sittings immediately, and in the first place the special treatment of measures to be dealt with, and especially the nomination of a sub-Committee was decided upon, which should be charged with the drawing up of a general programme. This Sub-Committee was composed of MM. Mohn, Weyprecht, and Wykander.

At their first meeting it was deemed necessary to take cognizance of the powers with which the different members of the Conference were invested, and they were invited to state how far their instructions went.

The result was, as stated in the protocols, that the representatives of the different Governments and Societies were not actually in a position to make definite promises, but that it might be affirmed generally, that in influential circles, if the participation were sufficiently large, there was a desire to co-operate in one way or another in the accomplishment of the resolutions arrived at by the Conference, the object of which was a scientific exploration of the Polar regions.

The remaining five meetings of the Conference took place on the 2nd, 3rd, 4th, and 5th of October, and in order to terminate the proceedings as quickly as possible, two meetings were held on the last-mentioned day.

The protocols of the proceedings were lithographed and placed in the hands of the different members of the Conference as quickly as practicable. These protocols are added to this Report as Appendices Nos. 5, 6, 7, 8, 9, and 10 (not printed here). As the Conference has resolved at its 4th meeting, on the 4th of October, that the protocols composed in the German language should be considered as the original edition, reservation was made that, without prejudice to the translation into any other language, a French translation especially should be given.

With reference to the resolutions taken by the Conference, these are conveniently separated into two groups, firstly, into those decisions which belong to a general nature; and secondly, into those embracing in detail the programme of the work in the Polar regions, and the manner of executing it. In the general part are to be included those decisions which refer to the extension of the participation in the scheme, and the steps necessary to effect that object. In the following summary the various decisions of the Conference are collated and presented in accordance with the classification indicated, without reference to the order in which they were proposed and adopted.

I.—General Part.

1°. The object of the undertaking which occupies the Conference is in the first place the investigation of the meteorological and magnetical, and generally the physical conditions of the Polar regions, and the immediately contiguous zones of the earth, according to a uniform plan to be determined by international agreement.

2°. These investigations are to be carried out especially at certain stations, and at fixed observatories to be established at the same, and commencing operations at the same time.

3°. The expenses of establishment and maintenance of such station or stations are to be borne by the country (or persons participating) undertaking their establishment.

4°. As a justification of the importance of the undertaking it should be set forth :—

(*a.*) *From a meteorological point of view*, that without an exact knowledge of the occurrences and phenomena which take place in the Polar regions, we cannot think of the possibility of establishing general principles and theories relating to the pressure of the air, the distribution and variations of temperature and air currents, the

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development and change of weather, or general climatological laws.

For the northern hemisphere, and especially for the meteorological phenomena in North America, Northern Europe, and Northern Asia, this proposal is evident *á priori*, and may be immediately demonstrated by a study of synoptic charts and of the results of simultaneous observations. Owing to the close connection of the Antarctic regions—undisturbed by continental influence—with the contiguous districts of higher latitudes within which the international traffic by sea is carried on, the establishment of general laws, on the one hand, can be essentially promoted, in consequence of the homogeneity of the earth's surface, whilst, on the other hand, the extension of meteorological investigation towards the south, by the further development of science cannot be dispensed with.

Especially important is the extension of the domain of synoptic, that is, of simultaneous meteorological work, towards the Arctic regions, for the development of the prognostication of weather and storms for the whole of Europe and North America.

(*b.*) From the standpoint of the science of terrestrial magnetism, that simultaneous observation at stations chosen according to certain points of view to be determined upon, in both Polar regions, for the development of the theory of the disturbances in the magnetic elements, whose relations to Aurora and sunspots is a condition without the fulfilment of which no decided advance in our knowledge can be hoped for.

(*c.*) That for the knowledge of the distribution of the magnetic force of the earth, and its secular and other changes over the earth, a thorough investigation at a definite epoch of the present time is evidently indispensable.

(*d.*) That the hydrography of the oceans—the theory of the distribution of heat and currents—is wanting in those fundamental factors by the help of which alone a scientific foundation, sufficing for all requirements, can be obtained, so long as a thorough examination of the polar regions, by means of accurate instruments, does not exist.

(*e.*) That the knowledge of the figure of the earth is incomplete, and rests partly upon hypothesis, so long as no certain measurements exist, according to the most recent methods, in the polar regions and especially in the northern hemisphere.

5. It is shown sufficiently from these concise arguments, given to justify the importance of systematic scientific researches in the polar regions, that in almost all branches of science, and other reasons drawn from the natural sciences could be added to the list, the progress of human knowledge will be limited and retarded without the extension of scientific facts by means of observations in those parts of the earth.

6. With respect to the natural sciences generally, the Conference has to impose upon itself certain limits, because it represents especially the interests of meteorology and terrestrial magnetism; but it is also its duty to make further limitations with regard to these branches of science.

7. In order to ensure the attainment to the end proposed, the Conference deems it expedient, with reference to the physical sciences, to distinguish more minutely between compulsory and special observations.

8. Compulsory observations are those which must absolutely be taken, if the system of observation is not to remain incomplete, and omissions to arise which would materially compromise the deduction of general results, and presumably even make them impossible. These comprise all meteorological and magnetical observations, observations of the aurora borealis, and hydrographical surveys, in which simultaneity must be held as a first condition.

9. The domain of special observations cannot be here precisely determined, because this would be synonymous with a catalogue of all the sciences interested. It will suffice here to draw attention to some individual observations; such as pendulum observations to determine the figure of the earth; hydrographical observations made at the fixed stations attached

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to the expeditions; astronomical determinations, referring to atmospheric refraction; the radiant points of meteors, &c.

10. With respect to the choice of places of observation (stations) the Conference unanimously arrived at the following decisions:—

Considering the importance of the western and northern regions of Europe for the meteorological conditions of the northern hemisphere, and considering the importance that the investigation of the influence of the zone of the greatest intensity and frequency of the aurora borealis must have upon the character of the variations in the magnetic elements, the Conference proposes the establishment of fixed stations at the following points of the northern hemisphere:—

1. Spitzbergen.
2. Finmark (North Cape).
3. Nova Zembla.
4. Mouth of the Lena.
5. Point Barrow.
6. A point in the Archipelago of North America.
7. Upernavik (West Greenland).
8. Jan Mayen, or the east coast of Greenland.

11. The Conference further declared it to be its well-considered opinion that the occupation of the stations named at least was absolutely necessary for the complete solution of the problems in the domain of Meteorology and Terrestrial Magnetism.

12. In consideration of the importance of synchronous magnetic observations in the Arctic and Antarctic regions for the extension of our knowledge of the character of magnetic disturbances, and of systematic meteorological observations in high southern latitudes, the Conference is of opinion observing stations should, if practicable, be established and maintained for a definite period at the following places:—

1. Island of South Georgia.
2. Kerguelen Island.
3. Auckland or Campbell Island.
4. Balleny Island, if a landing is possible.

13. The Conference is of opinion that negotiations with the Government and the International Meteorological Committee, and the preliminary arrangements for carrying out the scheme of Polar exploration will be expedited by taking the observations in 1881, 1882, and that accordingly endeavours should be made that these observations should be begun in the northern hemisphere in the summer of 1881, and that they should be continued for at least a year.

14. With respect to the publication of the observations taken during the period in question, the Conference expresses its opinion in the following points:—

(*a.*) All the observations are to be published *in extenso* as soon as possible.

(*b.*) As it will be of importance that, for the synoptical investigations of the meteorological conditions during the period of observation, an abstract of the meteorological observations should be forthcoming as soon as possible, it should be urged, with the concurrence of the International Meteorological Committee, that at the latest *one* year after the termination of the observations, so far as this may be possible, the publication of such an abstract should be made, according to an uniform plan to be settled by the above-named Committee.

(*c.*) It is very desirable that the whole of the observations, wherever measures come into question, should be published in metric measures, and the temperature in degrees centigrade.

15. The Conference is of opinion that international participation, in addition to the Governments, Societies, &c., already represented at this Conference is indispensable to the success of the enterprise, and hopes that the proximate convening of a second and more generally attended Conference, after this preliminary one, will meet with success, and setting out from this point of view, it adopts the following resolutions:—

(*a.*) The promotion of the matter with the different Governments, Societies, &c., must be taken up energetically and without delay.

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(*b.*) The Conference should declare itself to be a permanent International Polar Commission, until the solution of the problems for which it has been assembled, and should constitute itself as such immediately, by the election of a President, in order to have a central point for the direction of business and the promotion of the scheme.

(*c.*) The Conference desires that the International Polar Commission should be increased by the addition of delegates from other countries which have not been represented at this meeting.

(*d.*) The report and protocols of the proceedings of this Conference should be brought to the knowledge of the International Meteorological Committee without delay, with a request for their energetic support in the accomplishment of the resolutions adopted.

16. In order to obtain, by the carrying out of a common plan detailed in Part II., as complete contributions as possible for the solution of the meteorological and magnetical questions over the whole globe, the International Meteorological Committee is requested :—

(*a.*) To have the comparison of instruments, recommended by the Congress of Rome, especially that of barometers, carried out as soon as possible.

(*b.*) To take care, in good time, that not only the activity of the meteorological and magnetical stations already existing should be as comprehensive as possible, and extended in individual details during the periods of observation, but also that temporary stations should be established wherever a good connection between the proposed Arctic and Antarctic observing stations, and the actually existing stations in the temperate zones does not exist.

(*c.*) To exert its influence that the magnetic observatories upon the continents also should take more frequent observations upon the term days fixed by the programme of actual work, and at least at the special hours defined (as per protocols not printed here).

(*d.*) To exert its influence, that all over the globe, and especially in higher latitudes, as many self-recording instruments as possible be employed during this period, and that a certain selection of stations of the second order take observations several times a day, at equidistant and synchronous epochs.

(*e.*) To exert its influence that the Navies and Mercantile Marines of the different maritime nations should take part during the same period in the observations named under (*d*).

II. Special Part containing details respecting Observations, Instruments, and Epochs.

The Compulsory Observations in the Domain of Meteorology.

17. *Temperature of the Air.*—Mercurial thermometers graduated to 0°·2 C., and spirit thermometers graduated to whole degrees and verified at the Central Offices to 0°·1 C. are to be used.

18. The exposure is to be according to M. Wild's instructions, 1·5 to 2·0 metres above the ground, and in a double screen, furnished with louvres. The outer screen is to be made of wood, and the inner one of metal. The reading of the minimum thermometers may be effected in various ways.

19. The spirit thermometer must be compared with the standard mercurial thermometer, at the place of observation, at the lowest temperature attainable.

20. *The Temperature of the Seawater*, wherever possible, is to be observed at the surface, and at the depth of every 10 metres. The following instruments are mentioned incidentally as useful :—

Thermometers: Ekmann, Negretti and Zambra, Miller-Casella, Jansen, &c.

21. The freezing point of all the thermometers used is to be determined from time to time.

22. *Air pressure.*—At each station at least two good verified mercurial barometers, a spare barometer, and aneroids must be provided.

23. The principal barometer should be verified at least once a day.

24. *Humidity.*—Dry and wet bulb thermometers and hair hygrometers,

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with Regnault's apparatus as a check, are to be used, according to M. Wild's instructions.

25. *Wind.*—The wind vane and Robinson's anemometer to be read off in the house (see the construction of the Swedish apparatus at Spitzbergen). Simultaneous estimation by Beaufort's scale to 16 points, direction by true bearings.

26. In order to decide the question whether cups with large or small diameters are to be recommended for determining the force of wind in Polar regions, it is desirable that preliminary experiments should be made before using such instruments.

27. *Form and Amount of Clouds.*—The motion of the strata at different heights should be observed to 16 points of the compass.

28. *Precipitation.*—Occurrence and duration of rain, snow, graupel (soft hail), and, where possible, the amount, the determination of which is compulsory only in summer, should be noted.

29. *Weather.* — Thunderstorms, hail, fog, hoar frost, and the optical phenomena of the atmosphere are to be indicated.

COMPULSORY OBSERVATIONS in the DOMAIN of TERRESTRIAL MAGNETISM.

30. *Absolute determinations.*—For the Declination and Dip an accuracy of one minute, and for Horizontal Force, 0·001 is to be aimed at; among the instruments may be mentioned, for instance, the portable theodolite of Lamont and ordinary dip instruments.

31. The absolute observations must be carried on in close connexion with and synchronous with the readings of the variation instruments, in order to enable one to reduce the indications of the latter to an absolute normal value, and to determine the zero points of the different scales. The determination must be carried out frequently, to enable the changes in the absolute values of the zero-point of the scales of the variation-apparatus to be accurately checked thereby.

32. *Observations of Variation.*—These should include all three elements and should be made by means of instruments with small needles (the opposite to the Gauss apparatus). For the purpose of an uninterrupted mutual control it is desirable to have two complete sets of variation-instruments which is further to be recommended in order to avoid an interruption of the observations from breakage or derangement of the instruments.

33. The horizontal force, in one of the sets at least, should be observed by the unifilar apparatus. Owing to the great disturbances to be observed, the scales of the variation-instruments must have a range of at least 10°, and arrangements must be made to obtain a simultaneity of readings as far as possible.

34. The variation instruments must be read from hour to hour, during the whole period. It is desirable that two readings at intervals of a few minutes should be made, for instance, before and after the complete hour.

35. With reference to this resolution, M. Weyprecht presented the following separate request :—

Separate request.—"As hourly readings, not made at precisely definite instants of time, appear to me to be insufficient, to determine in those regions of almost incessant disturbances such periods and mean values as express the character of the disturbance of the place and of the epochs sufficiently accurately for comparison, and considering the small increase of work which would be caused by repeated readings at definite instants of time. I cannot agree with the opinion of the majority of the Conference.

"I declare that in any case the Expedition to be conducted by me will read all three variation instruments hourly at—
"—h. 58m., —h. 59m., —h. 60m., —h. 61m., —h. 62m., Göttingen Time.
"WEYPRECHT."

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36. The first and fifteenth of each month were fixed as term-days, reckoned from midnight to midnight, Göttingen Mean Time. The readings are to be taken every five minutes, at the completion of the full minutes, and the three elements are to be observed as quickly as possible after each other in the following order: horizontal force, declination, vertical force.

37. At such term-days magnetic observations are to be included in the plan of work, and are to be taken continuously, for instance, each 20 seconds during a full hour, even if they be for one element only. In the opinion of the Conference it would be most convenient to begin an observation so that one of the hours of observation may fall on the first hour of the first of January, and should be so continued through the period of observation that at each succeeding fortnightly term-day another hour is chosen for this purpose.

38. The exactitude of the magnetic observations is to be given in minutes for the declination, and to the fourth decimal place for horizontal and vertical force.

39. On the term-days continuous observations of the aurora borealis are also to be made. In addition the aurora is also to be observed from hour to hour, both as regards form and approximate position as to height and true azimuth bearings. The intensity of the light is to be estimated according to four grades.

40. The individual phenomena of the aurora are also to be made the subject of precise observation, and the different phases are to be noted, together with the simultaneous readings of the magnetic variation instruments.

41. As the greatest possible synchronism in the readings should be aimed at, determinations of place and time should be made with instruments fixed at the stations (Altazimuth instrument, and Transit instrument) which should not, however, prevent the use of good reflecting instruments. Every effort must be used to obtain as quickly as possible a suitable determination of position (especially longitude).

Special Observations.

42. The Conference earnestly recommends the following observations and researches to the attention of all those entrusted with the preparation of instructions for an expedition, or who are called to take part in one of the expeditions.

43. *Meteorological.*—The decrease of temperature with height, earth temperature, the temperature of snow and ice at different depths are to be determined.

44. *Observations of solar radiation* should be made, as well as those of *spontaneous evaporation.* The latter should be determined in winter by weighing cubes of ice, and in summer by means of atmometers.

45. *Magnetical.*—Absolutely synchronous readings from time to time of all three elements of terrestrial magnetism, with a view to the exact determination of the relation between the simultaneous variations of horizontal and vertical force.

46. *Earth currents.*—Observations of Earth currents in close connection with the magnetic observations and the phenomena of aurora borealis.

47. *Hydrographic investigations.*—Observations of currents, and the motion of ice—both as to direction and force.

48. *Deep-sea soundings*, and observations on the *physical properties of sea water, e.g.*, determination of temperature, specific gravity, gaseous contents, &c., and with this object the ships employed in the expeditions should especially be kept in view. Wherever possible tidal observations should be made by self-registering apparatus.

49. *Parallax of Polar light.*—Determinations of the height of the aurora borealis by measurements (for instance with the meteorographs (*sic*)), which should be made by detached observation parties, taking when possible simultaneous observations of the variations of declination.

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50. Observation on atmospheric electricity, on astronomical and terrestrial refraction, on the length of a simple seconds pendulum, on the formation and growth of floating ice and glaciers. Collection of specimens of air for analysis. Observations and collections in the domain of Zoology, Botany, Geology, &c.

After the Conference at its Fifth meeting had discussed further details as to the carrying out of the observations during the proposed Polar expeditions, and had given up the idea of communicating them, or of formulating them, as definite resolutions in the present stage, it proceeded to constitute the International Polar Commission by the election of a President.

M. Neumayer was unanimously elected President of the Commission, with the idea that it would thereby be possible to proceed immediately to the execution of the individual resolutions, in so far as this initiative lay with the Commission, and could naturally belong to it.

At the Sixth meeting of the Conference the protocols of all the meetings, including the last, were confirmed, and the President then declared the Conference to be closed.

Buys Ballot.
Hoffmeyer.
Lenz.
Mascart.
Mohn.
Neumayer.
von Schleinitz.
Weyprecht.
Wykander.

Members of the International Polar Conference,
Hamburg, 6th October 1879.

APPENDIX IV.

Sir, Hamburg, 23rd July 1880.

In compliance with the request of the International Meteorological Committee, published in the *Zeitschrift für Meteorologie*, p. 278, I venture to submit the following proposal to the Committee, and earnestly to recommend its adoption, believing that it deals with a very essential defect in the method of notation and publication of the observations at present pursued. The more precise reasons for this proposal have been stated by me in an article now in the hands of Dr. Hann, and will be printed in the *Zeitschrift*. Dr. Hann has kindly undertaken to communicate this argument to the Committee, either in print or verbally.

The proposals contained under heads, 1° and 2° are in direct connection with each other, as the carrying out of the first is the preliminary condition for the adoption of the second. A third point, in which an improvement of the notation of hydrometeors appears desirable, although not so urgent, is the publication of a revised list of international symbols; as those published in the protocols of the Vienna Congress and of the Utrecht Conference exhibit many imperfections which are, I believe, of an accidental nature, rather than of principle. It would lead me too far to set forth in detail the objections against the individual symbols; the accompanying list appears to me however, as regards the illustration of the object:—elegance, and facility of drawing (*e.g.*, ϟ instead of ≺) to offer considerable advantages, and yet does not differ in all points more from the two mentioned, than the different styles of writing an alphabet do, and there is no fear therefore of misunderstanding; with the exception perhaps of the addition of the symbols for thunder (instead of thunderstorm), and for squalls, about the desirability of which you will probably agree with me.

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As, however, I hold these alterations to be more a question of taste and convenience, than a real need of science, and as I consider them more as a matter of detail for the publishing Meteorological Institutions, I content myself with drawing your attention to them, and have not included them in the proposals which I made to the Committee.

Yours respectfully,

R. H. Scott, Esq. Dr. W. Köppen.

● Rain.
✳ Snow.
△ Soft-Hail ("Graupel").
▲ Hail.
≋ Mist, Fog.
Dew.
Hoar-frost.
⊕ Solar Corona.
Lunar Corona.
Lunar Halo.
○ Solar Halo.
V Silver-thaw ("Rauh-frost," "Duft").
~ Glazed Frost ("Glatteis").
Snow-drift.
→ Ice Crystals.
Lightning.
T Thunder.
Strong wind.
● Rain Squalls (*a.*)
Rainbow.
Aurora.
∞ Dust Haze ("Höhenrauch").

(*a.*) In the same way, by putting the proper symbol below the slanting arrow, squalls of another kind may be denoted, *e.g.*, ✳ snow squalls, △ soft-hail squalls, ● thunderstorm squalls.

PROPOSAL for a REFORM of the NOTATION and PUBLICATION of OBSERVATIONS of RAINFALL, &c.

1°. It is necessary in the interest of climatology, as well as of synoptical meteorology, that precaution should be taken by suitable alterations in the forms for observation and in the instructions for observers, as well as in the form of publication, for the unequivocal record of the hydrometeors existing at the moment of observation (especially rain, snow, hail, and soft hail). In publication this can be effected, by making the columns for the record of cloud observations wider, so that the above signs, together with the exponents 0 and 2 may be able to take a place next to the figure for cloud, if at the time of observation one of the specified hydrometeors existed (in the event of want of space, the most important would suffice). The observer's remarks, the detailed publication of which is very desirable, can be given with advantage, according to Kupffer's method, and as now done in the Annals of the Austrian Central Office, at the side of the tables, where they are not cramped for room.

With regard to the term "the moment of observation," each observation takes altogether a certain time, the observer can only be directed to make a fixed rule for the rotation in which the individual meteorological elements are to be observed, and to refer the estimation of the amount of cloud, together with the statement whether it rains, snows, &c., to a definite specified limit of time. The expression "Rain in showers," which is very suitable for the remarks because very characteristic, which is denoted by "*p*" in the Beaufort scale, is therefore of course to be entirely avoided in the notation of the weather at the moment of observation, as well as the likewise indefinite expression "rainy." These remarks refer, so far as regards the original day-books and instructions, to observers at sea as well as to those at fixed stations.

2°. It is desirable to introduce as a new element into meteorological summaries for land and sea, an expression for the "duration of rain" or for the "absolute probability of rain," in one of the three forms :—

$$\frac{r}{n}, \quad \frac{r}{n}\,N., \text{ or } \frac{r\,N}{n\,d},$$

in which n is the total number of times of observation.
r. the number of times of observation with rain.
N. the total number of hours in the period under consideration (Month).
d. the number of days on which rainfall is noted.

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Therefore $\frac{r}{n}$ = the "absolute probability of rain."

$\frac{r}{n}N$ = the probable total continuance of rain in hours in the period under consideration.

$\frac{r\,N}{n\,d}$ = the average duration of the rain upon a wet day.

Dr. W. KÖPPEN.

APPENDIX V.

Det Danske Meteorologiske Institut,
Copenhagen, 11th May 1880.

IN a treatise upon the storms of the Atlantic Ocean, copies of which I have had the honour to send to your honourable Committee, I have endeavoured to demonstrate how it would be possible to remedy, to a certain extent, the disadvantage of the situation in which the European meteorological service is placed, owing to our continent being bounded on the west by the ocean; and I have indicated, as a practical means, the establishment of meteorological stations on the Färoe Islands, Iceland, Greenland, and the Azores, in telegraphic communication with Europe.

I leave your honourable Committee judges of the value of this demonstration, but if it were required to show a conclusive proof of it, I would venture to draw attention to the fact that in pronouncing in this sense upon the scheme, the Committee would not only succeed in impressing upon it a seal of authority which my name alone is far from being able to give to it, but that it might become a powerful support, in bringing the scheme to a practical result.

In recommending this matter to your Honourable Committee, I cannot omit adding that I hold myself constantly at their disposal to furnish such information on this subject as might appear necessary or desirable.

N. HOFFMEYER,
Director of the Danish Meteorological Institute.

To the International Meteorological Committee.

APPENDIX VI.

Det Danske Meteorologiske Institut,
Copenhagen, 22nd May 1880.

IN order to draw up the meteorological summaries of each day, and to judge of the importance of the atmospheric conditions, as well as their probable consequences, it would be very convenient to have some information, as reliable as possible, on the mean values and extremes of the elements of the weather at the stations which serve as a basis for the *international* and telegraphic meteorological service. The best thing would evidently be to know these data for rather short periods, for instance for pentades or decades, but the means and extremes even for each month would be of great assistance.

In the event of your honourable Committee sharing this view, I would venture to request it to take care that the materials necessary for this end were published in a convenient form, either by each individual country, for those stations for which the telegraphic reports relating to the weather are sent abroad, or, perhaps still better, by means of centralisation in one of the meteorological institutions; and in accordance with communications received from the other meteorological establishments.

N. HOFFMEYER.

To the International Meteorological Committee.

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APPENDIX VII.

Berlin, 20th January 1880.

With reference to the preparation of a meteorological bibliography (§ 9 of the Programme), the Second International Meteorological Congress at Rome proposed the selection of the printed catalogues of the libraries of the Brussels Observatory and of the Meteorological Society of London as a starting point, and that each Central Meteorological Office should add the titles of those works which were not already contained in those catalogues; but, with respect to the second part, containing meteorological memoirs, that the work undertaken by Professor Cleveland Abbe should serve as a basis. The communications made to be by some meteorologists who have paid special attention to this question, as well as my own researches on this subject, have induced me respectfully to submit a few detailed proposals to the International Meteorological Committee.

1°. Catalogue of separate meteorological works.

On a close examination of the above-mentioned Brussels and London Catalogues, one is easily convinced that it is not practicable to select them as a starting point, as they are already methodically arranged. Assuming that the Central Meteorological Offices possess either a card-catalogue arranged according to names of authors, on a methodically classified catalogue, or merely a register of books received, or, lastly, only a position catalogue, it would in all four cases be equally tedious to pick out those works which were not contained in the printed catalogues in question, especially so in those many works which, owing to their manifold contents, would naturally be quoted several times. This procedure would only be rational when the printed catalogue, which was to serve as a basis, was arranged strictly alphabetically according to authors. Hence it appears to me best to give up entirely all reference to those catalogues, and to request from each central office simply a copy of its manuscript catalogue, however it may be arranged. The combination of all titles received, after the duplicates have been examined and struck out, taken in connection with the material contained in the published catalogues of Brussels and London, and any other material which may be available would furnish a tolerably complete catalogue of separate meteorological works. In addition to these contributions of individual institutions, an examination should be made of all those published catalogues which, although not specially devoted to Meteorology, contain works in the domain of this science. I have endeavoured to acquaint myself with the condition of the literature in question, and can say that at least about 40 such catalogues exist. General bibliographical works, second-hand catalogues, &c., which are mostly issued by booksellers, are also of the greatest use for such a work, especially in those issued by German-speaking countries, where the book trade has been carried on so methodically for a long time, the titles of all works containing Meteorology, which have appeared in the trade, are very easily accessible.

It appears to me, finally, that it would be a great guarantee for the completeness of the proposed work if the surprisingly extensive manuscript catalogue, which Mr. J. Symons, of London, has compiled in 24 folio volumes, were utilized in the preparation of the catalogue. I have myself inspected this work during a stay in London, and can say that I know of nothing more complete in this subject. Mr. Symons has expressed his willingness, in a letter to me of which a copy is annexed, to place the material which he has collected at the disposal of the Committee, on condition that it would defray the cost of extracting the titles of the meteorological works. If we assume that the expense of copying 100 titles, including the price of cards, would cost 4*s*., the Central Office at Vienna, of which the library, according to a communication from Dr. Hann, numbers about 3,600 meteorological works, would have to make an outlay of about 7*l*. for this purpose; and this sum would be generally proportional for the

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other institutions. I estimate the cost of the extraction of Mr. Symons' catalogue at about 15*l.*, which would have to be borne in common. With respect to the preparation of the raw material, I shall only remark that here also uniformity in the work is a principal condition of success. All titles must be copied on to cards of the same size, say like the one annexed, which Professor Cleveland Abbe has used, and according to correct bibliographical principles: (1) surname of the author; (2) initials of christian names; (3) exact titles of the work; (4) what edition; (5) place of publication; (6) year of publication (of the edition in question); (7) numbers of volumes, parts, &c.; (8) size of the work. The titles of works in the following languages: French, Italian, Spanish, Portuguese, Roumanian, German, English, Dutch, Danish, Norwegian, Swedish, need only be given in their original language, but works written in any other but the above languages must also be translated into (say) French.

2°. Catalogue of Meteorological memoirs, &c.

With regard to the second portion of the proposed bibliography, containing meteorological articles which have appeared in journals and periodical proceedings of learned societies, &c., I beg in the first place to draw attention to the annexed copy of a letter from Professor Cleveland Abbe, who has at the present time (*Zeitschrift der oesterreichischen Gesellschaft für Meteorologie*, Feb. 1879) already used the Royal Society's Catalogue as a basis of this work, as I had proposed to do. If then Professor Cleveland Abbe's work were used as a starting point—and there appears to be no reason against it, especially as he himself so willingly places it at our disposal—he would have to be paid the cost of copying, amounting to about 90*l.* Professor Abbe estimates the number of titles extracted from the first six volumes of the Catalogue in question at about 23,000. In the meantime the 7th and 8th volumes of this *Catalogue of Scientific Papers*, embracing the period from 1864 to 1873, have appeared, so that the cost of extraction of these volumes has to be added. As, however, in the preparation of this work all smaller notices and remarks, which often contain important communications, as well as all articles which contain in the main only observations, without discussions of any length, have been systematically omitted, all periodical papers specially devoted to Meteorology must be searched afresh in this respect, in the same way that MM. Houzeau and Lancaster have done with astronomical journals in the preparation of their excellent classified Bibliography of Astronomy. I have endeavoured to find out all the journals which are either wholly devoted to Meteorology, or in connexion with a kindred science, and they number 33, some of which, however, only existed for a few years and have long since ceased. This number will, no doubt, surprise many persons.

It is evident that notwithstanding the defects of the Catalogue of Scientific Papers it must serve as a basis of the work, if we consider, on the one hand, how meteorological articles, especially in the past, are to be found dispersed through all possible journals, of geography, medicine, statistics, and agriculture, and when we know, on the other hand, how great and manifold the number of papers extracted for that catalogue is.

For this second part of the bibliography we further possess valuable preliminary works in the bibliographical publications of some Academies, of which I would especially mention those of St. Petersburg, Berlin, and Brussels (in addition to the Royal Society).

The last and most difficult question of the scheme appears to me to be this—if the material is collected as completely as possible, who would examine, arrange and get it printed; and out of what funds should the costs incurred be defrayed? Should, say, one Central Institution perform this task, while a second, third, &c. should undertake the carrying out of other works of an international character?

I do not venture to express any opinion on this matter here, but think I have shown in the foregoing remarks, that by a closer examination of the question how the materials for the preparation of a meteorological bibliography are to be obtained, so many points of detail crop up to be settled, that it appears to me that the International Meteoro-

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logical Committee will not be able to discuss them thoroughly at its meetings, if it has the same character as the former Permanent Committee. If, however, any good result is to be arrived at in this direction, it will not be possible for the Committee to do otherwise than appoint a Special Commission for this question, either restricting itself to its own members, or obtaining advice from specialists outside its own body. In the same way a Committee of the British Association for the Advancement of Science some years ago prepared a valuable report upon a similar subject—The Bibliography of Mathematical Tables.*

A careful study of the preceding question has led me to this conclusion, and as author of the proposal which the Congress at Rome favourably received, I feel it my duty to draw the attention of the International Meteorological Committee appointed by that Congress to the matter.

GUSTAV HELLMAN.

R. H. Scott, Esq., F.R.S.,
Secretary International Meteorological Committee.

62, Camden Square, London, N.W.,
July 25th, 1879.

DEAR SIR,

I AM quite ready to do all that I can to assist. My catalogue, as you know, is the result of nearly 20 years' search, and is I believe the fullest in existence, as regards separate works and reprinted articles.

It is arranged strictly alphabetically under author's names, the plan which I think best for a universal catalogue.

It contains Astronomy, Climatology, Magnetism, and Meteorology.

I think that the course to be adopted would be for me to go through the volumes and mark all works coming under the heads of Meteorology and Climate, and then let my own copyists take out all these titles on stiff paper and send them to whoever prepares the catalogue. Although this involves taking out some hundreds of titles which are already in (say) the Brussels catalogue, I believe that it would be both safer and cheaper than trying to select titles not yet published.

The slip titles, whence the catalogue of the Meteorological Society was compiled, are still preserved, and could be lent for a few months without much inconvenience.

I think if these two sets were incorporated and put in type, proofs might be sent to each Central Meteorological Institute with a request that all additions should be written on stiff paper slips of a specified size. These additions being collected and inserted, your catalogue would be complete.

In conclusion, I have only to state that although it would be quite reasonable for me to ask some pecuniary return for the time I have devoted to the compilation of my own catalogue, I do not do so. I leave that entirely to the decision of the Permanent Committee; but as I hold no Government appointment, receive no salary whatever, and have to pay for all copying, it will be necessary to arrange for defraying its cost. I cannot tell the amount, but probably the best plan would be a specified sum for each hundred titles. I do not at all know the number of meteorological entries, but the entire catalogue fills 24 folio volumes.

G. J. SYMONS.

Herrn Dr. G. Hellmann.

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* Published in the Report for 1873.

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Specimen of Card.

HERSCHEL, (*Sir*) *John Frederick William.* Report of a Committee appointed for the purpose of superintending the scientific co-operation of the British Association in the system of Simultaneous Observations in Terrestrial Magnetism and Meteorology.—Brit. Assoc. Rep. 1841, pp. 38-41.

DEAR SIR, Washington, August 22nd, 1879.

YOUR letter of the 6th was received to-day, and I will reply that I shall be very glad to assist in your Bibliography of Meteorology so far as I may be able.

In 1874 or 1875 I was officially assured that the Royal Society of London did not contemplate publishing an index by subjects as promised in the introduction to the first volume of the "Royal Society Catalogue of Scientific Papers." I therefore at once began a systematic examination of every title in this latter catalogue, affixing a mark to each one that in any way related to Meteorology and its application to other sciences or arts.

I have thus examined every title in the first six volumes, and an amanuensis whom I employed for this purpose has copied the titles upon cards of uniform size, as specimens of which I enclose a few that were rejected for some defect. Numerous errors of printing, &c. were corrected in the course of this work. The seventh volume I have as yet only

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partially examined and have not begun to copy. I have estimated that my total outlay upon this work has, thus far, amounted to about 450 dollars (90*l.* sterling). The cards are arranged alphabetically in the order in which they are copied. My intention has been to further examine and copy in similar manner the titles given in the 7th and 8th volumes of the Royal Society Catalogue, and then to consult numerous other summary information, beginning with Poggendorff (Bib. Lit. Handwörterbuch), and Reuss (Commentationes), etc. etc.

This card catalogue was originally intended only for my own personal use, but if the "Permanent Committee" or yourself personally will repay me the expenses that I have incurred, and will undertake to complete and publish the bibliographical work, giving me some credit for what I have done, then I will transfer to you, or the Committee, all of my cards as a nucleus for your further work.

CLEVELAND ABBE.

Herrn Dr. Gustav Hellmann.

Berlin, July 20th, 1880.

IN continuation of my communication of the 20th January last addressed to the International Meteorological Committee as to the possibility of the preparation of a general meteorological bibliography, as proposed at the Congress of Rome, I now venture to make a few further remarks, intended to throw light upon the purely practical side of the question, which is at present the most important. In doing this I omit entirely all reference to the third portion of the work, the Catalogue of Meteorological Observations hitherto taken, because this must be prepared by the Central Offices themselves, and because no accurate account of the extent and cost of the same can be obtained at the commencement.

The natural starting point of the following calculation of expenses is an estimate as reliable as may be of the extent of the projected bibliography, including both separate works as well as articles and notices. I start, therefore, with the published Brussels' Catalogue, as the most copious of the special catalogues in question, and with the new bibliographical work which MM. Houzeau and Lancaster are compiling, of the Bibliography of Astronomy.

The Brussels' Catalogue contains about 1,500 titles in Meteorology and Terrestrial Magnetism, of which, however, scarcely the half (700) are of separate works. If we assume, then, that in reality eight or nine times more such works exist, we obtain an aggregate, in round numbers, of

60,000 titles

of separate published works.

The probable number of titles of articles and notices I calculate from analogy of the collection which MM. Houzeau and Lancaster have obtained from the Royal Society Catalogue and from scientific journals for the above-mentioned Bibliography of Astronomy. The Royal Society Catalogue produced 16,000 titles, the examination of scientific journals gave 14,000 more, making 30,000 titles altogether. If we assume, then, that Astronomy, as the elder sister of Meteorology, must possess a much more abundant literature than the latter, we may take an aggregate, in round numbers of

25,000 titles

of meteorological articles as not being too low.* On the whole, therefore, we could reckon on 31,000 titles, or to take too high rather than too low a figure, say

32,000 titles.

As the proposed bibliographical work should receive a convenient lexicon-octavo form, there might be on one page (two columns to a page) 25 titles, together with occasional small bibliographical notices, and about

* If Professor Cleveland Abbe has extracted about 23,000 titles from the Royal Society Catalogue alone, this was owing to a too wide limitation of the domain (partially including pure physics, &c. &c.)

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400 titles conveniently brought into one sheet, so that the whole work would take 80 sheets,

viz. :— 1st Part (separate works) say 25 sheets
2nd Part (articles and notices) say 55 sheets.

I am indebted to some of the leading publishers and printers in Leipzig and Berlin for the following technical account of the preparation of such a work :—

Per sheet = 16 pages = 32 columns ; edition of 500 copies.

	£	s.	d.
For setting up - - -	4	10	0
For press-work and printing -	0	12	0
For paper - - - -	0	13	0
Total - -	5	15	0

For every additional 100 copies, *i.e.*, reprint, 3*s.* 6*d.* for printing and paper should be added.

These prices would, however, be much *increased* if the manuscript were illegible, and consequently many corrections necessary, or if subsequent insertions were made. If we do not take both extreme cases and reckon the unavoidable cost of correction at only 20% of the above sum, the printing per sheet would cost :—

£ s. d.
6 18 0
7 13 0 } for an edition of { 500 / 1,000 } copies.

In the event of the latter case, viz., an edition of 1,000 copies—and such a work would retain its value for centuries—the technical cost of preparation would be, for

	£
Setting up, printing, and paper -	632
Bookbinders' work - - -	15
Title, and binding in boards -	10
Total - -	657

It is much more difficult and uncertain to estimate approximately the cost of the preparation of the manuscript for the press. In the following attempt at such an estimate, I make in the first place the two preliminary conditions :—

1°. That the preparation of the work, after the principles have been internationally agreed upon, shall be entrusted to one or several competent persons.

2°. That the individual Central Offices will do their utmost to furnish the raw materials gratis.

The best thing appears to me to take an actually printed title as the unit for the calculation of the cost, and to estimate the cost of compilation at 31 centimes (say 3*d.*) per title,

assuming that a portion of the editorship (the last revision and critical supervision) is done without cost, or at least at a cost not corresponding to the trouble and labour of such an arduous undertaking as the preparation of any general bibliography.

If we assume that the extraction of the Royal Society's Catalogue can be purchased from Professor Cleveland Abbe for 90*l.*, and that the extraction of Mr. Symons' manuscript catalogue could be bought for, say 15*l.*, and that the acquirement of other appropriate catalogues, &c., would cost 30*l.*, the whole cost of compilation might be reckoned as follows :—

	£
Compilation of 32,000 titles - - -	400
Professor Cleveland Abbe's catalogue - -	90
Mr. Symons' catalogue - - - -	15
Purchase of other catalogues, &c. - -	30
Total - -	535

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The aggregate cost of a bibliography, 80 sheets thick, and an edition of 1,000 copies, would consequently amount to—

	£
Cost of technical production - -	657
Cost of editorship - - -	535
Total - -	£1,192

That this result of our calculation of, in round numbers, 1,200*l.* would be approximately correct, is shown by the comparison with the cost of the bibliography of Astronomy, which, according to the kind communication of the authors, amounted to 1,000*l.*, in which, however, scarcely any cost for editorship is included, as MM. Houzeau and Lancaster, respectively Director and Librarian of the Royal Observatory of Brussels, were not specially paid; otherwise, the expense would not have amounted to less than 1,400*l.*

On the ground of the foregoing discussion, we thus arrive at the conclusion that the possibility of the production of a general Meteorological bibliography is dependent upon the fulfilment of the following three conditions:—

1°. That the Central Meteorological Offices should furnish a copy of the catalogues of their libraries or of certain portions of them, free of cost.

2°. That a competent person should undertake the superintendence of the whole, according to principles to be agreed upon internationally.

3°. That the sum of 1,200*l.* should be collected by international contributions, by subscriptions, or by other means.

The possibility of success will depend essentially on the third point—the money question. I will make a few further remarks upon this point.

The sale of the Meteorological Bibliography would naturally be relatively small; with the exception of scientific institutions and scientific men, we can only reckon upon the larger public libraries as purchasers; and even if the International Meteorological Committee should use all its influence in the collection of a number of subscriptions, at the best scarcely 250 subscribers would be found. It may serve as a comparison that only 150 persons subscribed for the Bibliography of Astronomy. If then the work were sold at 2*l.* 10*s.* per copy, 250 copies would only fetch 625*l.*, or not one half of the actual expense, for perhaps 20 per cent. of the receipts would, in this case (subscription) fall to the commission agent, who for the remaining copies sold in the book trade would, as usual, take fully 50 per cent. of the published price. Therefore, only in the most favourable case, of the remaining 750 copies being sold in the trade, and a real income of $\frac{1}{2} \times 750 \times 50s. = 937l.\ 10s.$ being made, would the total cost be fully covered.

It will be seen that this is *impossible for the present:* all requirements, for the time being, would be satisfied by the sale of say 250 copies, and it is only on account of the bibliography having a lasting value, and in the course of years losing little of its saleability, that it might happen that after 50 years, or more, the whole edition of 1,000 copies would be exhausted. Therefore the plan of subscriptions cannot lead to the desired end, because the cost of the work must be covered at once, and there only remains the possibility of obtaining the funds by international means, if the preparation of the work is not undertaken by an individual country, as has been done by Belgium for the Bibliography of Astronomy in such a very creditable manner.

If, for instance, 30 bodies cover the cost by contributions of 40*l.* each, for which they would receive a certain number of copies gratis, a portion of the outlay might, in some years be refunded to them, so that they would have to bear, say, only the half of the actual expense, viz. 20*l.* We might even assume the favourable case, that the whole edition of 1,000 copies would be sold, and that the contributors might make a profit of, say 9*l.*, viz.:—

Six free copies representing a value of 15*l.*

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If the net gain of the sale of the remaining copies reaches
$\frac{1}{4} \times 820 \times 50s. = 1{,}025l.$

	£	s.	d.
for distribution among the 30 copies, each would receive	34	3	0
in addition to the value of the free copies - -	15	0	0
	£49	3	0
The expenses being - - - -	40	0	0
Leaving the gain - - - -	£9	3	0

This method of procedure would, therefore, not be unlike shareholding. Without wishing to speak of an actual gain, I wish to show by this example that the expenses for individual bodies would, in fact, not be so great as might appear at first sight.

G. HELLMANN.

APPENDIX VIII.

REPLIES to the CIRCULAR as to the CARRYING OUT of the RESOLUTIONS of the CONGRESS of ROME.

CIRCULAR.

International Meteorological Committtee,
St. Petersburg and London, 30th October 1880.

SIR,

IN the sixth sitting of its meeting at Berne the Committee read through the resolutions of the International Congress of Meteorologists at Rome, a resumé of which will be found in Appendix XI. of the Report of Proceedings of that Congress. From the information which the members of the Committee gave verbally on this occasion respecting the carrying out of these resolutions in their countries, the Committee decided that it would be useful to publish these data in the Appendix to the protocols of its meeting, and resolved to request all the directors of meteorological systems to furnish similar information to the Committee. In this way the Appendix in question would give a more complete idea of what had been done generally in carrying out the decisions and the wishes of the Congress of Rome.

You are requested therefore to be good enough to communicate as soon as possible to Mr. R. H. Scott (Meteorological Office, 116, Victoria Street, London) the remarks which you have to make respecting the carrying out of the resolutions of the Congress of Rome in your country.

Accept, &c.
(Signed) H. WILD, President,
R. H. SCOTT, Secretary,
For the International Meterological Committee.

ANALYSIS OF THE REPLIES TO THE PRECEDING CIRCULAR.

Replies have been received from the following gentlemen:—

Austria - -	Vienna - -	Dr. J. Hann.
Baden - -	Carlsruhe - -	Dr. Sohncke.
Denmark -	Copenhagen -	Capt. Hoffmeyer.
France - -	Paris - -	Prof. Mascart.
Germany -	Berlin - -	Dr. Hellmann.
,, -	Hamburg -	Dr. Neumayer.
Great Britain and Ireland - -	London -	Mr. R. H. Scott.
Holland -	Utrecht -	Prof. Buys Ballot.
Hungary -	Buda-Pesth -	Dr. Schenzl.
Italy - -	Pavia - -	Prof. Cantoni.
Norway - -	Christiania -	Prof. Mohn.

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Portugal	Lisbon	Capt. de-Brito-Capello.
Russia	St. Petersburg	Prof. Wild.
Saxony	Leipzig	Prof. Bruhns.
Spain	Madrid	Senr. Aguilar.
Switzerland	Zürich	Dr. Billwiller.
Würtemberg	Stuttgart	Prof. Schoder.

For Denmark and Spain respectively Capt. Hoffmeyer and M. Aguilar state that they carry out their operations in conformity with the resolutions of the Congress of Rome. In all other cases the special replies will be found under the heads of the different countries, arranged in alphabetical order, but only with reference to such resolutions as call for such replies.

Resolution 4.

"The Congress proposes that each country be invited to establish at a certain number of points, regard being paid to local conditions, stations at which continuous observations should be made by means of self-recording instruments, or else hourly observations during several term-days in each month, or lastly continued, equidistant, and frequent observations (eight times a day at least), in order to obtain the necessary data for reducing to true means the means of observations made twice or thrice a day at ordinary stations."

AUSTRIA.—Cracow, Fiume, Klagenfurt, Kremsmünster, Lesina, Pola, Prague, and Trieste are supplied with self-recording instruments. The mountain stations of Obir and the Skhafberg have only barographs.

BADEN.—There are no stations of the first order.

BELGIUM.—Continuous observations have been made by means of self-recording instruments at Brussels for the last 40 years. Automatic apparatus on von Rysselberghe's principle will be shortly erected at Ostend, Arlon, and Maeseyck; that is at the three corners of the kingdom.

FRANCE.—There are several stations which comply with the requirements of this question; *e.g.*, Parc St. Maur, Lyons, Clermont Ferrand, St. Martin de Hinx, &c.

GERMANY.—Berlin. Two-hourly observations of temperature and wind are taken at the Powder Magazine at Mecklenburg Schwerin, and will be published from January 1880.

GERMANY.—Hamburg. In the system of the Deutsche Seewarte, and therefore on the coast of Germany, the following stations are designated as normal observing stations of the first order:—

1. Memel.	Barograph and anemograph, and	all the other instruments.
2. Neufahrwasser.	Do.	do.
3. Swinemünde.	Do.	do.
4. Wustrow.	Do.	do.
5. Kiel.	Do.	do. and a thermograph.

6. Hamburg. A double series of self-recording instruments, and all other instruments.

7. Sylt.	Barograph and anemograph, as Memel, &c.	
8. Wilhelmshafen.	Do.	do.
9. Borkum.	Do.	do.

It is proposed to publish the results of the self-recording apparatus in tabular form: 1878 will soon be ready, and contains the results from four stations only; 1879 will have five or six.

10. Leipzig is a station of the first order.

11. Munich has self-recording apparatus of old pattern, but without an anemometer.

12. At individual observatories (astronomical) there are barographs and thermographs, and at some places anemometers in connexion with automatic tide gauges.

13. Kaiserslautern. A station of the first order has been established this year.

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14. Magdeburg. A station, with self-recording apparatus, is the property of the publisher of the "Magdeburger Zeitung."

15. At Frankfort-on-the-Maine the Physical Association has established an observing station, with barograph, thermograph, and anemograph.

GREAT BRITAIN AND IRELAND.—In addition to the seven observatories in connexion with the Meteorological Office,—Aberdeen, Armagh, Falmouth, Glasgow, Kew, Stonyhurst, and Valencia,—the observatories of Greenwich and Oxford (the Radcliffe Observatory) possess complete outfits of self-recording apparatus.

In addition, the Bidston Observatory (Liverpool), and that of the Earl of Crawford at Dunecht, possess barographs. And there are numerous anemographs on the coast.

HOLLAND.—At Utrecht, pressure, temperature, and magnetic declination, as well as the force and direction of wind, are recorded continuously on the Cathedral tower, at the height of 328 feet, and at the Central Institute; at Helder and at Groningen, the pressure, temperature, and force and direction of wind are recorded hourly; at Flushing pressure and wind force and direction hourly.

HUNGARY.—The values deduced by Jelinek for some localities in Hungary have been hitherto used as corrections for barometrical and thermometrical readings. No stations of the first order have as yet been established in the country, nor could hourly observations be carried out. At the Central Office there are many years records of barographs and thermographs still unreduced.

ITALY.—There are three stations of the first order: Milan, Naples, and Rome.

NORWAY.—There are no stations of the first order, nor any meteorographs. The Director, however, hopes to obtain funds for providing such.

PORTUGAL.—Two observatories, Lisbon and Coimbra, are furnished with self-recording instruments for the principal meteorological elements. These suffice for the deduction of the meteorological elements for the coast stations, which are not at a great elevation above the sea level.

SAXONY.—There is one station provided with self-recording apparatus. It seems needless to supply such to other places owing to the limited area of the kingdom.

SWITZERLAND.—Self-recording instruments, recording every 10 minutes the state of the meteorological elements, are erected at Berne. At Geneva and on the Great St. Bernard readings are taken at two-hourly intervals from 6 a.m. to 10 p.m. In the reduction of the individual means corrections from a long series of observations at Geneva and on the St. Bernard (by interpolation by means of Bessel's formula) are applied, but at present for temperature only.

Resolution 5.

"The Congress recommends the general adoption of the forms of publication already introduced in several countries for observations at a certain number of stations of the second order chosen in each country as international stations. (See the Reports of the Committee for 1873 and 1874, p. 9, third meeting at Utrecht, and Appendix F.)

"The monthly and yearly resumés published by the central offices for the different stations contain, in accordance with the resolutions of the Congress of Vienna, a summary of the frequency of the eight principal directions of the wind, both for the months and for the year. Seeing the importance which must be attached, not only to the direction but also to the *force of the wind*, the Congress proposes (in accordance with M. Weihrauch's proposal) to publish also in these summaries the *mean force* of each wind, and for the greatest possible number of stations for each month and for the year. Where the form adopted allows sufficient space, the figures representing the frequency and the mean force should be placed side by side: otherwise it is preferable to give both in the form of an appendix.

"The observation of the direction of the upper clouds, and especially of cirrus, at some stations of each country, and the publication of these observations in the form of an appendix, is strongly recommended, and

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also the publication of observations on the temperature of the surface of the ground. (Question 18.)"

BADEN.—The annual reports for Carlsruhe have for years contained the monthly and yearly means of wind force for the stations of the Grand Duchy of Baden.

BELGIUM.—The observations are published in conformity with the international form of publication.

FRANCE.—The form recommended has been adopted since 1878; the observations are given in detail for 22 stations, of which 12 are in France and 10 in Algeria; in addition, monthly resumés are published for 71 French and 36 Algerian stations. Charts are published showing for each month, and for the year, the prevalent direction of wind, the distribution of pressure, mean temperature, and rain in France and adjacent countries. The documents are preceded by a climatological review.

GERMANY.—Berlin. In the general publication of the Meteorological Institute of Germany (exclusive of Bavaria), the "Meteorologische "Beobachtungen in Deutschland angestellt auf 17 Stationen "zweiter Ordnung," the observations of five Prussian stations are published in extenso, on the international form.

Since 1879 the international form has been adopted for the month and yearly resumés.

Cirrus observations for some stations have been included for the year 1880.

GREAT BRITAIN AND IRELAND.—Returns have been published on the international form for the year 1878, for 25 stations in detail, and for eight additional stations, in the form of monthly abstracts.

The stations are in connexion partly with the Meteorological Office, and partly with the Meteorological Society (London).

The observations are taken at 9 a.m. and 9 p.m., local time.

HOLLAND.—At Utrecht the components of each wind are calculated, those winds being combined which are in the same quadrant.

HUNGARY.—The mean monthly and annual wind force will be published from the year 1880 in the Jahrbücher of this Institute, from the stations of the second order, in the form required by the Congress.

Underground temperatures are at present observed at only one station (Hódmezö Vásárhely). At the central observatory (Buda-Pesth) thermometers have been plunged to the depth of one metre, but observations have not yet been commenced.

PORTUGAL.—Since January 1880 the monthly observations of all the continental stations, of those in the Azores and in Madeira, and of two stations in Africa, St. Thomas and San Paolo de Loanda (14 in all) are published on the international plan. Previously only the stations we call international were so published.

RUSSIA.—The international form of publication has been introduced since 1874.

With the year 1880 the calculation of the mean force of each wind has been taken up again for our stations, and will be published in due time in the annals.

In the year 1880 most stations have been provided with thermometers for the observation of the temperature of the earth's surface, or that the results of the observations can be published in future, together with those of the motion of the clouds, in the appendix to the annals.

SAXONY.—At Leipzig and Dresden, Robinson's anemometers are erected, and the indications of wind force obtained from them will be included in our publications. At other stations where it is difficult to find suitable exposure for anemometers it is only possible to estimate the direction and force of the wind, the latter on Beaufort's scale. It is only for Leipzig and Dresden that the velocity corresponding to each direction of the wind can be given in metres per second.

The direction of the clouds is observed at Leipzig, and will in future be included in the publications.

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SWITZERLAND.—The form of publication referred to has been introduced for a limited number of our stations (11–15) since February 1874. With reference to the summary of wind observations, it is to be remarked that owing to the configuration of our country, these are of such a local nature that it would be of comparatively little use to draw up the resumés in monthly or yearly tables, without any explanatory text. It would appear more suitable for this country to exhibit the wind observations in close connexion with an explanation of the conditions of the land, which could best be done in separate treatises.

Resolution 6.

"The Congress recommends the general adoption of the code of figures for meteorological telegrams proposed by the Permanent Committee of the Vienna Congress at its fourth meeting at Utrecht."

BELGIUM.—The code is in use.

FRANCE.—The code is in use.

GREAT BRITAIN AND IRELAND.—The code is in use.

PORTUGAL.—The reports from Madeira and Lisbon are sent to Paris, according to the code adopted by the Congress of Rome. We receive, in addition, reports from eight French stations and from the observatories of Madrid and San Fernando on the same code.

RUSSIA.—The international code has been adopted for many years.

SWITZERLAND.—With a few modifications the general code has been adopted. The changes have been determined by the limited extent of our system, and are chiefly contractions.

Resolution 9.

"The directors of the different meteorological systems are invited to prepare catalogues of the published and unpublished observations in their respective countries, and to inform the International Committee of the work already done in that direction."

BADEN.—The list of the printed and MS. series of meteorological observations, memoirs, and works has been published in the Seventh Annual Report of the Central Station, Carlsruhe, for 1875, which appeared in 1877.

BELGIUM.—The observatory of Brussels will soon undertake the preparation of all the observations made in the country which are either in print or in MS. At the same time it will prepare a second edition, considerably enlarged, of the catalogue of its library.

GREAT BRITAIN AND IRELAND.—A list of all the works published by the Meteorological Office appears on the cover of every publication.

HOLLAND.—Prof. Buys Ballot has prepared a list.

HUNGARY.—A list of the meteorological observations made prior to the establishment of the Central Meteorological Office will be shortly prepared.

PORTUGAL.—A catalogue of all the publications of this observatory, including the observations made at various stations, has been recently made and will be published shortly.

We shall also compile a catalogue of meteorological works and memoirs, although these may be of slight importance.

SAXONY.—A list of all series of observations made in Saxony, both published and unpublished, will be compiled and published shortly.

A list of the books in the library which are not found in the catalogues of the Meteorological Society or of the Brussels Observatory will be prepared.

SWITZERLAND.—Several old series of observations have been published in the Schweizerische Meteorologische Beobachtungen (see p. xv. 1877). A catalogue, as complete as possible, of all the published and unpublished observations is in preparation.

Resolution 10.

"The Congress recommends the directors of all central institutions to have their instruments compared with the standard instruments of other countries."

BADEN.—Prof. Sohncke says, "I have made a fresh comparison of the "Carlsruhe barometer (on Fortin's principle) with the standard baro-

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" meter of the Zürich Observatory, in August 1880. The result will " be published in the Annual Report of my office for 1880."

BELGIUM.—The barometer and a standard thermometer belonging to the observatory were compared with the standards of Kew Observatory.

HOLLAND.—Our normal barometer has been compared by Prof. Dove, subsequently by M. Rikatcheff, and in 1875 with the barometer of the Deutsche Seewarte by Dr. Neumayer. We possess also two barometers verified at Kew which are 0·5 mm. lower, and a French barometer by M. Ernst. We have also two thermometers verified at Kew, as well as one by Fastré and one by Baudin.

HUNGARY.—The Central Office is not in a position to undertake a comparison of the standard instruments, and must defer it until it has an observatory of its own.

SWITZERLAND.—We are quite ready to compare our standard instruments with those of neighbouring countries, and think we can commence it in 1881.

Resolution 13.

"The Congress considers the following subjects as possessing a general interest:—

(*a.*) Critical collection and discussion of all existing data on the diurnal range of air temperatue, and attempts to deduce general laws therefrom.

(*b.*) Critical collection and discussion of all existing data on the diurnal and annual range of absolute and relative atmospheric humidity, and attempts to deduce general laws therefrom.

(*c.*) Critical collection and discussion of all data on the diurnal and annual range of the state of the sky, that is, of the amount of cloud.

(*d.*) Wind tables for the 12 months and for the year.

(*e.*) Tables of precipitation for the 12 months and for the year.

(*f.*) New tables of atmospheric pressure, with isobars, for the 12 months and for the year.

(*g.*) Charts of the movements of storm.

(*h.*) Daily synoptic charts embracing considerable portions of the globe.

The directors of central institutions are invited to have these works executed as soon as possible for the stations of their respective countries and published, in order that they may serve as a basis for researches which may be undertaken on the general march of meteorological phenomena over the surface of the globe."

BELGIUM.—Both MM. Quetelet, father and son, have published several memoirs on the march of temperature at Brussels.

M. Lancaster published last year a paper on thunderstorms in Belgium.

FRANCE.—The observations of thunderstorms are summarised and published each year, with charts of the march of the principal storms. The observations of rainfall, published *in extenso* each year for more than 1,100 stations, are further summarised for seasons and for the year; they are accompanied by a notice on the system of the rainfall, and by charts showing the distribution of the amounts of water for each season and for the whole year. Lastly, one volume of the *Annales du Bureau Central* is specially devoted to articles on general meteorology.

HOLLAND.—For Utrecht and some other stations the required tables are given in several publications.

PORTUGAL.—We have already published a resumé of the meteorology of Portugal and also another very detailed investigation into the barometer and thermometer readings during the 20 years, 1855–75. This memorandum will be revised as soon as possible for the barometer, thermometer, and hygrometer for the years 1855–80.

RUSSIA.—A critical discussion of the daily and yearly range of temperature for Russia has been carried out by Dr. Wild. A similar inquiry

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for rainfall has just been undertaken in the Central Physical Observatory.

SWITZERLAND.—The investigations here mentioned are indicated in the programme of the Central Meteorological Office, which will soon be enlarged, and be established as a Government office. Hitherto, *i.e.*, as long as the Institute was maintained by the Natural History Society, and only subsidised by the State, the sphere of its action was very limited, consisting chiefly in the collection of observations.

Resolution 15.

"(1.) The reduction of barometer readings to the sea level by the addition of a constant quantity during the whole year is only admissible for heights not exceeding 20 metres, if we wish to obtain an accuracy of $\pm 0{\cdot}5$ mm. ($\pm 0{\cdot}002$ in.). Consequently, for stations situated at a height exceeding 20 metres, account must be taken of the temperature and approximately of the relative humidity, according to Laplace's method.

"(2.) In weather reports it is desirable that the barometric readings unreduced should be given by the side of the readings reduced to the sea level; in other publications it is *necessary* to have in all cases unreduced readings.

"(3.) It is desirable that the International Meteorological Committee should undertake the compilation of fresh uniform tables for the reduction of barometric readings to the level of the sea.

"(4.) It is equally desirable that the Committee should undertake the preparation of a collection of tables which may be employed in the meteorological systems of the different countries."

BELGIUM.—The reduction of the barometer to sea level is made in conformity with the recommendations of the Congress.

HOLLAND.—Having demonstrated theoretically in the Jaarboeker and practically by the deviations (écarts) that reduction to sea level for considerable heights is unsafe, I reject all reductions for the stations on table lands and on mountains, and practically admit it only for Maestricht (height 54 metres.)

HUNGARY.—The reduction of the barometer readings to sea level for all stations except Fiume is done by Laplace's method. The calculation of the vapour tension and the relative humidity is effected by Dr. Wild's tables.

RUSSIA.—In the daily bulletin of the Central Physical Observatory the unreduced barometer readings are always given by the side of those reduced to sea level.

SWITZERLAND.—Points 1 and 2 are fulfilled.

Resolution 16.

"The Congress is of opinion that the method indicated in M. Pernet's report on the determination of the fixed points of thermometers should be provisionally accepted."

RUSSIA.—The fixed points of the thermometers have been determined in the Central Observatory according to the rules laid down by M. Pernet.

SWITZERLAND—We shall endeavour to carry out this resolution soon.

Resolution 17.

"The Congress, without actually prescribing a fixed form of thermometer screen suitable for different climates, and even for the exigencies of observers, draws the attention of meteorologists to the reports and communications presented to the Congress, either as printed papers, or in the protocols of the meetings of the Committee."

BELGIUM.—Hitherto we have used Stevenson's screens, but lately Renou's screen's have been erected with double roofs and without louvres We shall shortly commence comparative observations.

SAXONY.—Three stations of the third order have been provided with double zinc screens, for the protection of thermometers, of the pattern referred to by Dr. Wild and myself. The other stations have in part simple zinc screens, in part sheltering boards over the top, so that the temperatures observed may correspond as closely as possible to the conditions of nature.

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Resolution 18.

"The Congress has not been informed of any new experiments made on the subject of Earth Temperature since the date of the Vienna Congress, and in conformity with M. Wild's suggestion, proposes to admit the temperature of the surface of the earth among the meteorological elements to be observed at stations of the second order."

BADEN.—Earth temperatures not observed.

FRANCE.—Observations relative to the temperature of the earth at different depths have been made for 20 years at the Museum of Natural History of Paris, by MM. Becquerel; they are continued, and are regularly published. Three or four new stations are in course of organisation.

GERMANY.—Berlin. From the year 1881 the temperature of the soil will be observed at a few selected and suitable stations.

GREAT BRITAIN AND IRELAND.—Earth temperatures not observed at the stations in connexion with the Meteorological Office. Observations are taken at Greenwich and Edinburgh, and at some of the stations of the Scottish Meteorological Society.

HOLLAND.—Earth temperatures not observed.

HUNGARY.—Observations of earth temperature are not carried on at all the stations of the second order. I shall, however, endeavour to have such experiments made at some of the forest stations.

PORTUGAL.—We have made during the whole of the year 1879 daily observations of underground temperature at depths of 1·5, 1·1, 0·7, 0·3, and 0·05 metres, by means of Becquerel's electric thermometers. Since January 1880 we have taken observations at depths of 10 and 5 metres in addition to the others, and we have also made direct observations at the same depths as those enumerated above, with Lamont's earth thermometer, in order to compare the results of the two methods, direct and electrical.

RUSSIA.—See remarks under No. 5.

SAXONY.—Earth temperature observations have been made at 12 stations during a series of years, mostly with a set of eight thermometers at depths of 0·1, 0·25, 0·50, 0·75, 1·00, 1·50, 2·00, and 3·00 metres. The observations are published in the volumes of the results of Saxon stations.

SWITZERLAND.—We expect to have observations of earth temperature made on the surface and beneath at the agricultural and forest stations which will soon be established in the country.

Resolution 19.

"The Congress finds that the researches into the subject of radiation are not yet sufficiently advanced to enable it to propose a method of observation, and considers that the question should be referred to the next Congress."

FRANCE.—The bright sunshine will be regularly observed from 1881 at a dozen stations, by means of the special apparatus known as the sunshine recorder.

GREAT BRITAIN AND IRELAND.—Sunshine recorders of the pattern devised by Prof. Stokes have been supplied to about 30 stations, and the results, which give the duration of bright sunshine, are published in the Weekly Weather Report.

PORTUGAL.—Since January 1877 we have observed M. Marié Davy's actinometer four times daily. The results are published in the Annals of the observatory.

Resolution 20.

"The Congress recommends the employment, as far as may be possible, of a regular arrangement for ventilation in the determination of the humidity of the air by means of the dry and wet bulb thermometers."

BADEN.—We have no arrangement for ventilating the wet bulb thermometer.

HOLLAND.—Ventilation is considered very important. I made my propositions about it in 1872, and ordered a hygrometer provided with an arrangement to ensure a current of air. This, however, is not so good as that which I saw at Berne and which I shall adopt.

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RUSSIA.—At the observatories of Pawlowsk and St. Petersburg the air in the thermometer screen has since the beginning of 1880 been always set in motion by means of a ventilator, in making direct hygrometric observations with the dry and wet bulb hygrometer. The velocity of the motion of the air by this means is about 2 metres per second. It is intended to introduce this ventilation gradually at the other observatories, and stations also, as an investigation into this matter made by Dr. Swarikin at the Central Observatory, which will shortly be published in the Repertorium, has definitely shown that the dry and wet bulb hygrometer, with the addition of a ventilator, becomes a very trustworthy instrument for hygrometric observations.

SAXONY.—Ventilation is not employed in the observation of the wet bulb thermometer, the method of moistening the thermometer shortly before observing and of waiting until it has reached its lowest point has proved the best here, better than the method of keeping it constantly damp by the capillary action of a cotton wick, &c.

SWITZERLAND.—We have not yet introduced the ventilation for the dry and wet bulb thermometers, but will recommend its adoption to the Meteorological Commission.

Resolution 21.

"The Congress points out that atmometers generally should fulfil certain conditions of comparability, and expresses the opinion that there is need of fresh researches being undertaken, for the determination of the form and exposure of the instruments to be employed."

HOLLAND.—Few things are of such importance as the study of evaporation I have requested the engineers of the Waterstaat to make experiments on a large scale.

PORTUGAL.—Since January 1880 we have every day observed Piche's atmometer placed by the side of, and at the same height as, the ordinary atmometer which has been observed at our stations in the country since 1863.

RUSSIA.—Wild's balance atmometer has been introduced for some years at upwards of 20 stations, and is everywhere similarly exposed. The comparable evaporation observations thus obtained have been discussed in a memoir recently published in the Repertorium für Meteorologie, vol. viii., "Researches on the various forms and "exposure of atmometers as carried on at the Observatory of "Pawlowsk."

NORWAY.—During the Norwegian Arctic Expeditions of 1876-7-8, I have made experiments on the evaporation of sea water with a floating atmometer. A calculation by Weilenmann's formula, however, does not give at all a satisfactory accordance with the measured values of the depth of water evaporated. The same result has come out of a series of observations with the instrument made on board the Norwegian corvette, "Nordstjernen," on a voyage to the West Indies and back.

Resolution 22.

"The Congress thinks, that for stations of the second and third order, a diameter of 8 or even of 4 inches is sufficient for the rain gauge.

"As to the position of the rain gauges the Congress confines itself to recommending that they should never be placed upon a roof, but that they should be sufficiently elevated to be out of the influence of drifting snow, and of the splashing of drops from the ground, while they must not be sheltered by trees or other neighbouring objects."

FRANCE.—The rain gauges have an area of 3 or 4 square decimetres; they are generally exposed at about 2 metres above the ground.

GERMANY.—Berlin. The new rain gauges have an area of $\frac{1}{20}$ of a square metre.

HUNGARY.—The rain gauges distributed by the Central Office have an area of $\frac{1}{10}$ square foot, only a few stations are provided with gauges of $\frac{1}{20}$ square metre area. Excepting in a few towns where erection near the surface of the ground is impracticable the gauges are placed at a height of from 1 to 2 metres above the ground.

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RUSSIA.—At the Central Physical Observatory investigations have been continued into the most suitable exposure of rain gauges, especially with reference to the accurate measurement of snow, by avoiding both its blowing out of the receivers and its drifting into them. In both directions the enclosure of the rain gauge, standing 1 metre above the ground, by a wooden screen of 2·5 metres in height, and at a distance of 2 metres, has hitherto been found the most effective.

SWITZERLAND.—These points are attended to as much as possible.

Resolution 23.

"The Congress does not feel itself prepared at present to reply to the question of the determination of wind velocity. It confines itself to recommending the directors of central institutions to effect a comparison between the anemometers employed in different countries."

BELGIUM.—For a long time the force of wind has been measured by means of an Osler's anemometer, which indicates, as is known, the pressure of the wind in kilogrammes. Since 1878 this instrument has been replaced by a Robinson's anemometer, which registers the velocity of the movement of the air. It was soon recognised that the indications of one of these instruments were not sufficient for the study of the various questions relative to the force of the wind, and it is proposed to observe both instruments, at the same time, when the new observatory is built.

HOLLAND.—At more than one station the velocity of the wind is observed and registered. At Utrecht the observations are entered on the same schedule as the force of the wind, in order to provide a better comparison than we as yet possess, even better than the comparative observations of Professor Stamkart, who was not able to obtain the two classes of observations from the same spot.

RUSSIA.—All meteorological stations in Russia are at least provided with Wild's pressure plate (the pendulum-anemometer), the indications of which are referred to the normal anemometer of the Central Observatory. Several observatories possess in addition a Robinson's anemometer which has been compared with this normal anemometer.

Resolution 23a.

"The observation of the direction of the upper clouds, and especially of cirrus, at some stations in each country, and the publication of these observations in the form of an appendix is strongly recommended."

FRANCE.—Cirrus clouds are regularly observed at Parc St. Maur.

GREAT BRITAIN AND IRELAND.—Cirrus observations are recorded at a few stations, but no results have been published yet, except in some papers by the Rev. W. Clement Ley.

PORTUGAL.—The observations of the motion of upper clouds have been made ever since 1877 at Lisbon and Campo Maior.

SAXONY.—It has already been stated in the answers to question 5 that the proposal of Dr. Hildebrandsson for the observations of clouds is carried out at Leipzig.

SWITZERLAND.—Cloud observations are carried on as completely as possible.

Resolution 25.

"The Congress is of opinion that the study of atmospheric electricity has made marked progress in recent years, and recommends that a comparison should be made between the instruments which are most generally used."

BELGIUM.—We are engaged in the erection of an apparatus permitting of the study of the distribution of atmospheric electricity of the successive strata of air in a vertical direction.

FRANCE.—Instruments are being erected at several observatories.

PORTUGAL.—This observatory has purchased a portable Thomson's electrometer, in order to make comparison with the results of one of Branly's electrographs, which has been working ever since 1877 in one fixed position. In the latter instruments we have lately

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adopted M. Mascart's system of insulation, which has considerably improved its indications.

Resolution 25a.

"After having heard with interest the Report of M. de Rossi on the phenomena, which he comprises under the term 'Endogenous Meteorology,' the Congress expresses a desire to see such researches continued, and insists upon the relations which may exist between them and those of general meteorology."

SWITZERLAND.—A special Seismometrical Commission appointed by the Natural History Society is charged with the collection and study of such data.

Resolution 30.

"A. The Congress, recognising the importance that observations made in balloons, especially at places situated in the interior of the continents, may have for the physical study of the higher regions of the atmosphere, recommends the taking of observations of temperature and humidity by means of captive balloons, and according to Glaisher's method, in strata at different heights, and on different days, and in different seasons. It recommends also the study, by means of captive balloons, of the diurnal range of temperature and humidity in the upper strata of the atmosphere and the detailed publication of these observations.

"B*a*. The Congress thinks that it would be very useful if observatories could possibly be established on the summits of mountains, and the observations published *in extenso*, so that that they may be placed at the disposal of all meteorologists, and may aid in the solution of problems which may present themselves in future.

"B*b*. The Congress insists upon the utility of a series of hourly observations of temperature, pressure, direction, and force of wind, and eventually also of humidity on Mount Washington, and especially at Pike's Peak, the highest station upon the earth. This series should embrace one year at least; and it would also be desirable to publish in detail the observations already existing for these two stations. General Myer is requested to be good enough to realise these desires of all meteorologists.

"B*c*. The Congress recommends the Swiss Society of Natural Sciences to do its utmost to promote the establishment of an observatory upon one of the high summits of Switzerland. It expresses the desire that meteorological stations may be established under similar conditions in Italy and other countries.

"B*d*. The Congress considers the establishment of the observatory of Etna, proposed by M. Tacchini, of that of Mont Cimone, proposed by M. Parenti, and that of Mont Ventoux, supported by the Meteorological Commission of the Department of Vaucluse, as enterprises of high scientific importance.

"C. The Congress requests the directors of the meteorological systems of the various countries to be good enough to publish in a complete manner the existing series of observations made at elevated stations, and which have either not yet been published, or only in an incomplete manner; and at the same time to indicate and describe the stations of their systems which might furnish materials for the study of the upper regions of the atmosphere."

AUSTRIA.—The observations on the Obir (Carinthia) 2,070 metres, and on the Schafberg, 1,776 metres, will be published *in extenso* in our Jahrbücher.

FRANCE.—The observations on the Puy de Dôme and the Pic du Midi are published.

GERMANY.—Berlin. In the course of this year two mountain stations of the second order have been established, the Schneekoppe (1,600 metres) and the Brocken (1,141 metres). These observations, as well as those of the corresponding stations on the plain below, Eichberg (348 metres) and Nordhausen (222 metres), are to be published *in extenso*.

A resumé of the old observations on the Brocken (1836–59 and 1866–7, with interruptions) will be published in the Report for 1880.

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As a supplement to Dr. Hann's Report on the observations on high mountains and in balloons, it may be remarked that the results of 10 years summer observations (May to October) on the Schneekoppe are given in Galle's Grundzüge der Schlesischen Klimatologie (Breslau, 1854).

HUNGARY.—Observations at high stations are not made, as generally high stations with us are uninhabited. Arrangements have, however, been made to place minimum thermometers at some high points in the Carpathians.

ITALY.—The observatory on Mount Etna has been completed and is nearly ready for observations in physical astronomy (with a great refractor), in meteorology, and terrestrial physics. In that fine southern climate, an observatory so large and provided with so good instruments, at a height of 2,950 metres, cannot fail to give results of great interest to science.

The arrangements for the establishment of an observatory on Mont Cimone, in the Appennines of Modena, are going on, and promise to secure the realisation of the project.

At the high stations of the Stelvio and Valdobbio it is hoped to establish self-recording instruments.

SWITZERLAND.—The project of a mountain station in this country was recommended by the Meteorological Commission, and the Säntis peak, 2,504 metres high and very isolated, was indicated as the most suitable point for the purpose. The requisite funds are, however, not yet perfectly assured, but will be so as soon as the Central Meteorological Office has at its disposal the proposed increased grant, owing to its being raised to the position of a Government institute.

Resolution 30a.

"The Congress draws the attention of meteorologists to the importance of measuring the variations in length and thickness of the glaciers in the different countries in order to be able to deduce the relations which exist between these variations and those of the meteorological elements.

"As a means of extending our knowledge upon this question, the Congress recommends:—

"To form a complete critical collection of observations made in times past upon the variations of volume of the glaciers.

"To institute in future continued observations at localities suitably chosen, upon the annual variations of the glaciers in length and thickness and to publish the results.

"The Congress hopes to be able to rely upon the co-operation of the Alpine Clubs and other analagous societies in carrying out these researches."

AUSTRIA.—Professor Richter (Section Salzburg of the Deutsch-Oesterreichischen Alpen-Verein) has put up marks on the Tauern of the Karlinger glacier and measured the lower end of the glacier in order to be able to register its changes. He has also dealt with the Upper Salzbach glacier, of which he made an accurate survey. He has been able to prove that during the last 20 years this glacier has diminished one twentieth in area, and the tongue has gone back 410 metres, *i.e.*, one fortieth of its entire length (1,896 metres). The profiles which have often been constructed show very clearly the decrease in size of the glacier. It has lost from 40 to 110 metres in depth in the last 30 or 40 years.

Bergrath Seeland, of Klagenfurt, has put up marks on the Pasterze in order to detect the changes in length of this glacier.

SWITZERLAND.—The Natural History Society, as well as the Alpine Club, further the study of glacier movements in every way in their power.

Resolution 32.

"The Congress cannot give effect to the proposal of Mr. Parkinson, who has asked for funds for organising a meteorological service in the Samoa Islands, because it has no international fund at its disposal; but with

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regard to the importance of this proposal, it expresses the hope that private initiative will permit of meteorological observations being taken in the Samoa Islands.

"The Congress considering—

"1°. That it is of the highest importance that the meteorological stations established by different countries in parts of the globe, which are very remote and difficult of access, may be visited from time to time, in order to ascertain the accuracy of the instruments and of the amount of confidence which can be placed in the observations;

"2°. That such an inspection may be most conveniently made by officers of the navies of the maritime powers,

Proposes to forward to the Governments of the countries represented at the Congress the request that they will kindly take the necessary steps that, on the one hand, the officers commanding vessels visiting those parts may receive instructions, in pursuance of which they would place themselves in communication with the observers at those meteorological stations, whatever be the nationality of the latter, for the purpose of comparing the instruments, and of acquainting themselves with the manner in which the observations are made; and on the other hand, that the observer charged with the care of the station may place himself at the disposal of the officer visiting it, whatever be the maritime power by which he is commissioned.

"The Congress recognises that the establishment of meteorological stations in Bulgaria, Roumania, and Servia would be of the highest importance, and it begs the Italian Government to cause this wish to be communicated to the Governments of those States."

GERMANY.—Hamburg. The German African Society in Berlin has sent out an expedition to Lake Tanganyika, where a station is to be maintained for two years. Although Dr. Kaiser reports from Zanzibar that one of the standard barometers is broken, he still hopes that he can organise the station satisfactorily with the instruments which are left. On the west coast of Africa a series of observations have been made by Herr Soyaure, at the factory of Herr Woermann of Hamburg. A good barometer by Fuess of Berlin has lately been tested at the Seewarte, and is now on its way to Africa.

There have been numerous instances of persons addressing themselves to the Seewarte, with reference to the establishment of observations in tropical regions. In every case, however, they have been informed that the Seewarte neither will, nor has the power to, undertake the management of such organisations.

GREAT BRITAIN AND IRELAND.—A complete outfit for a station of the second order was sent to Norfolk Island in 1878, and good observations have already been received.

A good barometer, compared at Kew, has also been sent out to Nain in Labrador, to the station maintained by the Moravian Brethren. Stations are maintained by the Meteorological Office at Bermuda, on Sombrero Island, at several lighthouses in the Bahamas, and at the Falkland Islands, but from the impossibility of inspecting regularly and effectually, the observations are not of much value.

Instruments have been sent out to Cyprus for six stations of the second order: Famagusta, Kyrenia, Larnaca, Limasol, Nicosia, and Papho.

GREECE.—From a letter addressed to Mr. Scott by Dr. Schmidt of Athens, it appears that there is but little prospect of meteorological observations from this country.

ITALY.—The Meteorological Commission is at present engaged in establishing a station in the Bay of Asab, near the Straits of Bab-el-Mandeb, and another at Alexandria, and it is intended to supply tested instruments and to send out capable observers.

JAPAN.—Mr. E. Knipping writes to Dr. Hann from Tokio, under date February 4, 1879: "The Imperial Meteorological Observatory of "Japan, which is admirably equipped, and at which five practised

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" observers are employed, has published since June 1875 daily " observations, with five-day means and monthly tables, and " thereby renders my observations, if not entirely useless, yet of " less importance, so that my work does not stand in any proper " relation to the results now obtained. I have therefore deter- " mined to close my observations with 1879.

" By personal inquiry I have learnt that the observatory here " will enter into relations with all foreign central offices, so that " there will be no interruption in the returns you receive from this. " I can add the satisfactory information that an observatory has " been established at Nagasaki a year ago, and since January 1879 " another in Hiro-shima (on the Inland Sea). Several others in " Hiogo, Sendai, Hakodati, and Sappro (both in Yezo) will be " established in future."

ROUMANIA.—M. Hepites makes careful observations at Ibraila which are published in the Jahrbuch of the Central Anstalt of Vienna.

RUSSIA.—The Central Physical Observatory has received complete Meteorological Observations, made by Lieut. Tjägin with the first instruments delivered at Nova Zembla, from August 1878 to August 1879, and these will appear *in extenso* in the Annals for 1879.

SOUTH AMERICA.—Mr. H. B. Joyner (formerly of Tokio, Japan) has commenced observations at Sao Paulo.

Dr. Walz of Bogotá has written to Dr. Bruhns (under date April 22, 1880), to request assistance from the International Meteorological Committee for the establishment of a station at that place.

APPENDIX IX.

REPORT on the METEOROLOGICAL ORGANISATION of ENGLAND in 1876,* being a Supplement to APPENDIX V. of the REPORT of the SECOND INTERNATIONAL CONGRESS at ROME.

Question 1.—*How many stations are there in your system?*

(*a.*) *How many of the* 1*st order?*
(*b.*) ,, ,, 2*nd* ,,
(*c.*) ,, ,, 3*rd* ,,

70, (1) viz., *a* 7, *b* 44 (including 29 telegraphic reporting stations), and *c* 19. In addition the Observatories of Greenwich, the Radcliffe Observatory, Oxford, and the Bidston Observatory possess self-recording instruments: six stations in connexion with the Meteorological Office possess anemographs: the Meteorological Society numbers 16 stations of the second order, and the British Rainfall system counts as many as 2,000 observers.

The Scottish Meteorological Society also possesses an extensive organization.

(1) In 1879, the total number of stations of the second and third orders in the British Isles in connexion with the Office was 22 and 24 respectively, and of those in England and Ireland in connexion with the Meteorological Society was 23 and 48 respectively.

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* The constitution of the Office was changed in 1877, and consequently these answers require modification in several particulars in order to show the conditions in 1880. The most important of the modifications are given in the notes.

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Question 2.—*Are these stations at which no self-recording instruments are used, but only eye observations made?*

(*a.*) *If so, to what uses are the latter put?*

At the stations of the first order, self-recording instruments are used. The monthly and five-day mean results for these stations for pressure and temperature are published in the Quarterly Weather Report.

The returns for the stations of the Second Order are published for climatological purposes, on the International scheme.

Question 3.—*What means are taken to ensure correctness at all the stations?*

Regular inspection almost every year, and constant close examination of the records.

Question 4.—*How often and at what hours are observations made?*

At the stations of the First Order six eye observations are made daily to control the automatic records. At those of the Second Order observations are made at 9 a.m. and 9 p.m. local time. At the Telegraphic stations observations are taken at 8 a.m., 2 p.m., and 6 p.m. Greenwich time, and at several of these stations the barometer is read at 10 p.m. also.

Question 5.—*How are the observations recorded? Who supplies the schedules?*

The observations are recorded in rough day books, and copied into monthly tables, all supplied by the Meteorological Office or the Society.

Question 5*a*.—*If supplied from the Central Office, is their cost defrayed from its own funds?*

The cost of printing is not defrayed out of the annual grant to the Meteorological Office.

See answer to question 17*a*.

Question 6.—*Are the observers paid? and if so, at what rate?*

The stations of the first order, the seven observatories, receive a regular annual allowance of about 250*l*. The observers at the stations of the second order are all volunteers. The Telegraphic reporters are paid about 13*l*. per annum.

Question 7.—*Who appoints the observers?*

The Telegraphic Reporters are the only observers appointed by the Meteorological Office, except in the case of the distant observatory of Valencia, which is managed from London, inasmuch as there is no local institution at that place with which it could be connected.

Question 8.—*Can they be changed?*

The Telegraphic Reporters can be changed. If any of the stations of the second order fail in accuracy the publication of their returns is discontinued.

Question 9.—*How often are the stations inspected?*

Almost without exception the stations are inspected every year.

Question 10.—*By what persons and at whose expense?*

The Director of the Office was in 1876 the sole inspector, but the observatories were also visited yearly by the Superintendent of the Central Observatory at Kew. (2)

The cost of inspection is borne by the Meteorological Office.

(2) Since 1877 separate inspectors have been appointed for the three kingdoms, the Secretary to the Meteorological Office inspecting Ireland. The stations in connexion with the Meteorological Society are inspected by its Assistant Secretary.

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Question 11.—*Who supplies instruments?*

At the observatories and the Telegraph stations the instruments employed are the property of the Meteorological Office. At the stations of the second and third orders the instruments are the private property of the observers.

In the branch of Ocean Meteorology (Question 22) all the instruments employed in the Royal Navy, and by the observers in the Mercantile Marine (upwards of 100 in number) belong to the Meteorological Office.

Question 11*a*.—*Are they verified before or after erection?*

All the instruments belonging to the Office, and all those employed at stations connected with it, are verified originally at Kew Observatory.

Question 12.—*What staff is employed in the Central Office?*

A director, a marine superintendent, 5 senior, 6 junior, and 8 temporary clerks, 1 engraver, an office keeper, a commissionaire, and a porter. (3)

(3) In 1879 the staff of the Office consisted of 1 Secretary to the Council, 1 Marine Superintendent, 1 assistant in the Marine Department, 5 senior, 6 junior, and 19 temporary clerks, 1 engraver, 1 office keeper, 1 commissionaire, 3 boys, and 1 porter.

Question 12*a*.—*Have any of the staff any other sources of official income?*

No.

(4.) *Question* 12*b*.—*What are the usual office hours?*

10 a.m. to 4 p.m., except in the Telegraphic Department, where the attendance is from 8.30 a.m. to 9 p.m. (4)

(4) In 1878 the hours were altered to 9 to 5.

Question 12*c*.—*Is residence or any other special advantage enjoyed by the director or any of the staff?*

No.

Question 13.—*How is the work divided at the Central Office?*

I. Ocean Meteorology; II. Weather Telegraphy; and III. Land Meteorology; and IV., in addition, Administration and Correspondence.(5)

I. Meteorology employs the Marine Superintendent, 2 seniors, 1 junior, and 3 temporary clerks.

II. Weather Telegraphy employs 1 senior, 3 junior, and 2 temporary clerks.

III. Land Meteorology employs 1 senior, 1 junior, and 4 temporary clerks, with 1 engraver.

IV. The Administration employs 1 senior and 1 junior clerk, with the office keeper and commissionaire.

The last three branches are under the special management of the director.

(5) In 1879 the staff was increased under I. by 3, under II. by 4, under III. by 6, under IV. by 2.

Question 14.—*Who appoints the clerks?*

The Committee of the Royal Society, who manage the Office.(6)

(6) In 1877 the Office was transferred to a paid Council nominated by the Royal Society and appointed by the Government.

Question 15.—*What salaries are paid to the clerks and to the superintendent?*

The Director receives 800*l*. annually, the Marine Superintendent 400*l*.; the 5 senior clerks together 1,000*l*.; the 6 junior clerks together 566*l*.; the 8 temporary clerks 540*l*. 16*s*.; the engraver 109*l*. 4*s*.; the office keeper 100*l*. These payments to the clerks are exclusive of what can be earned at overtime.(7) (Ques. 16*b*.)

(7) These salaries in the case of the clerks have been altered, owing to the increase in the hours of attendance. The Council receive 1,000*l*. a year.

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Question 16.—*Who pays these?*

The Committee, out of their grant from Government.

Question 16*a*.—*Are their appointments permanent, and is there any provision for superannuation?*

The appointments are not permanent, and there are no pensions.

Question 16*b*.—*Are there any extra allowances, e.g., for additional work or special services?*

The clerks are allowed to work at home at overtime, and those who attend at extra hours, as in the Telegraphic branch, and at the Reporting stations, receive extra pay.(8)

The funds for the Telegraphic extra pay are provided by the "Times" newspaper, for the use of which journal the arrangements are made.

(8) Overtime has been abolished, the hours of attendance having been increased. The arrangements with the "Times" were modified in 1880.

Question 17.—*What publications issue from the Central Office?*

The list of published books, &c. is printed on the cover of each publication of the Office.

In addition, lithographed Daily Weather Charts are issued to the number of about 500, more than half of which are distributed free.

The Hourly Readings of Pressure, Temperature (Dry and Wet thermometers), Wind (Direction and Velocity), and Rain at all the seven Observatories are also lithographed and distributed to the principal Meteorological Institutions.

Question 17*a*.—*From what fund is the printing paid?*

By Her Majesty's Stationery Office.

Question 17*b*.—*How many copies of your publications are distributed free?*

The number varies.

Of all publications there are distributed, 172 copies.

" " except Marine publications, 65 copies.

Of Marine only, 134 copies.

Of smaller publications only, 22.

Question 17*c*.—*How many are sold?*

Very few.

Question 18.—*Are there daily observations published from any stations as well as average (weekly or monthly), and if so from how many stations?*

The automatic records from the seven Observatories are reproduced in full in the Quarterly Weather Report. In addition, the hourly readings of the instrumental curves are lithographed, as explained in Answer 17.

For the year 1876 the observations at 9 a.m. and 9 p.m. have been published for the stations of the second order on Form A, in detail, for 15 stations; on Form B, in abstract, for 14 additional stations. In addition, daily observations for 29 stations are published in the Daily Weather Reports.

Question 19.—*Is provision made for the discussion of particular points in reference to storms, weather, public health, agriculture, &c., or in reference to more scientific questions?*

Various investigations into the history of particular storms, &c. have been published by the Office from time to time.

Numerous papers on such subjects, prepared in the Office, have appeared in the Quarterly Journal of the Meteorological Society.

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Question 20.—*Have any researches been carried on with a view to the improvement of instruments or methods of reducing observations?*

The Office has constantly directed its attention to the improvement of existing instruments, and methods of observation and reduction, in every branch of the science which comes under its sphere of action. The results are published in its Annual Reports.

Question 21.—*What is the cost of the Meteorological Department under all its different heads?* (1.) *For instruments.* (2.) *For stations.* (3.) *For observers.* (4.) *For cost of records.* (5.) *For transmission to Central Office.* (6.) *For verification of observations.* (7.) *For publication of results.* (8.) *For warnings of storms.* (9.) *For abstract physical and scientific results.*

The total expenditure of the Office in the year ending March 31, 1875, was 11,685*l.* 10*s.* 6*d.*

The Parliamentary vote was 10,000*l.*,(9) and the balance was received from various sources, such as the sale of instruments, subscriptions to the Daily Weather Reports, and the contribution from the "Times" newspaper for the evening Telegraphic Weather Service.

The amounts are distributed as follows:—

	1874–5. £ s. d.	1878–9. £ s. d.
Office—		
Salaries	1,314 19 0	2,512 10 8*
Rent, fuel, and furniture	603 2 8	576 8 7
Contingencies, printing, &c.	195 17 0	387 0 8
Special researches	—	270 3 11
Land Meteorology—		
Expenses at observatories	2,644 3 11	2,433 19 1
New instruments for do.†	391 12 9	51 9 6
Computations	763 11 2	1,361 19 0
Weather telegraphy	2,139 8 9	3,148 5 9
Inspections, D. W. Charts, &c.	583 2 3	292 18 1
Computations	665 6 8	1,266 4 4
Ocean Meteorology—		
Marine Superintendent	400 0 0	400 0 0
Admiralty instruments	265 15 0	353 11 0
Mercantile Marine do.‡	575 4 11	571 17 1
Computations, &c.	1,143 6 5	1,337 9 7
Total	£11,685 10 6	14,963 17 3

(9) In 1878 the Parliamentary grant was 14,500*l.*

Question 22.—*Does your Department deal with both Land and Ocean Meteorology?*

Yes, as already explained, and it supplies all the Meteorological Instruments used in the Royal Navy.

ROBERT H. SCOTT.

---

* Including honorarium to Council.

† The purchases of instruments for colonial establishments, &c. are included under the heads of "New Instruments for Observatories" and of "Mercantile Marine instruments."

‡ Including Instruments and Agency Accounts (seaports).

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For Her Majesty's Stationery Office.
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LIST OF PUBLICATIONS, &c. issued by the METEOROLOGICAL OFFICE.

OFFICIAL.

No.

1. Report for 1867. 1s.
2. Instructions for Meteorological Telegraphy. New Edit. (1875). 6d.
3. Fishery Barometer Manual. 6d.
4. Charts of Surface Temperature, South Atlantic Ocean. 3s. 6d.
5. Report for 1868. 5d.
6. Report for 1869. 10d.
7. Quarterly Weather Report for 1869.—Parts I. to IV. 3s. each.
8. Barometer Manual. (Out of Print—see No. 46.)
9. Quarterly Weather Report, 1870.—Parts I. to IV. 3s. each.
10. Report for 1870. 10d.
11. Contributions to our Knowledge of the Meteorology of Cape Horn and the West Coast of South America. 2s. 6d.
12. Currents and Surface Temperature of the North Atlantic Ocean, from the Equator to Lat. 40° N., for each month of the year, with a General Current Chart. 3s. 6d.
13. A Discussion of the Meteorology of the Part of the Atlantic lying North of 20° N. for the Seven Days ending 8th February 1870. Price, with Book of Charts, 5s.
14. Quarterly Weather Report, 1871.—Parts I. to IV. 3s. each.
15. Report for 1871. 10d.
16. Quarterly Weather Report, 1872.—Parts I. to IV. 3s. each.
17. Report for 1872. 1s.
18. Contributions to our Knowledge of the Meteorology of the Antarctic Regions. 9s.
19. Quarterly Weather Report, 1873.—Parts I. to IV. 3s. each.
20. Charts of Meteorological Data for Square 9. Lat. 0°–10° N., Long. 20°–30° W., and Remarks to accompany the Monthly Charts, which show the Best Hours across the Equator for each Month, &c. 20s.
21. Report of Proceedings of the Meteorological Congress at Vienna. 1s.

No.

22. Report for 1873. 4d.
23. Report of the Proceedings of the Conference on Maritime Meteorology held in London, 1874. 2s.
24. Instructions in the Use of Meteorological Instruments. 2s. 6d.
25. Quarterly Weather Report for 1874. Parts I., II., and IV. 5s. each. Part III. 3s. 9d.
26. Report for 1874. 6d.
27. Charts of Meteorological Data for the Nine 10° Squares of the Atlantic which lie between 20° N. and 20° S., and extend from 10° to 40° W., with accompanying Remarks, ending with the Best Hours across the Equator. 24s.
28. Contributions to our Knowledge of the Meteorology of Japan.—By Staff-Commander Thomas H. Tizard, H.M.S. "Challenger." 1s.
29. Report for 1875. 4d.
30. Quarterly Weather Report for 1875.—Parts I., II., III., and IV. 5s. each.
31. Report for 1876-7. 3s. 6d.
32. A Discussion of the Meteorology of the North Atlantic during August 1875, with 31 Synoptic Charts. 15s.
33. Quarterly Weather Report for 1876. Part I. (In the Press.)
34. Contributions to our Knowledge of the Meteorology of the Arctic Regions. Part I. 2s. Part II. 10s.
35. Report for 1877–8. 1s.
36. Report of the Proceedings of the Meteorological Congress at Rome, 1879. 1s. 6d.
37. Report on the Meteorology of Kerguelen Island. By the Rev. S. J. Perry, F.R.S., F.R.A.S. 2s.
38. Report for 1879–80. 5d.
39. Meteorological Observations at Stations of the Second Order for the year 1878. 20s.
40. Aids to the Study and Forecast of Weather, by W. Clement Ley, M.A. Price 1s.
41. Report from 1879–80. 1s.

Sold by Potter, 31 Poultry, and Stanford, Charing Cross.

The Annual Reports may be obtained of all Parliamentary Booksellers.

[1882.]

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LIST OF PUBLICATIONS, &c. issued by the METEOROLOGICAL OFFICE.

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No.

1. Report to the Committee on the Connexion between Storm Winds and Barometrical Differences.—By R. H. Scott, Director of the Office. 6*d.*

2. Report to the Committee on the Meteorology of the South Atlantic.—By Captain H. Toynbee, Marine Superintendent. 1*d.*

3. Report to the Committee of the Use of Isobaric Curves.—By Captain H. Toynbee, Marine Superintendent. 1*d.*

4. Routes for Steamers from Aden to the Straits of Sunda and back. Translated from a Paper issued by the Royal Meteorological Institute of the Netherlands. 6*d.*

5. On the Winds, &c. of the South Atlantic along the Tracks of Steamers from the Channel to New York. Translated from a Paper issued by the Deutsche Seewarte, Hamburg. 6*d.*

6. Report of the Proceedings of the Meteorological Conference at Leipzig. 3*d.*

7. Notes on the Form of Cyclones in the Southern Indian Ocean.—By C. Meldrum, Esq., M.A., F.R.A.S. 6*d.*

No.

8. Report on Weather Forecasts and Storm Warnings. Presented to the Meteorological Congress, Vienna. 6*d.*

9. Report of the Proceedings of the Vienna Congress. 1*s.* 6*d.*

10. On the Physical Features of the Ice of the Atlantic south of Newfoundland in 39° and 40° N., and extending from 10° to 40° W. A Paper read before the British Association at Brighton, August 1872, by Captain Toynbee, F.R.A.S., F.R.M.S., Marine Superintendent. 1*s.* 6*d.*

11. Report of the Permanent Committee of the Vienna Congress. 1*s.*

12. Reports on the Permanent Committee of the Vienna Congress on Atmospheric Electricity, Maritime Meteorology, and Weather Telegraphy, 1873. 3*d.*

13. Report of the Permanent Committee of the Vienna Congress on Ice. 6*d.*

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REPORT

OF

THE SECOND MEETING

OF THE

INTERNATIONAL METEOROLOGICAL COMMITTEE.

Held at Copenhagen, August 1882.

Published by Authority of the Meteorological Council.

LONDON:
PRINTED FOR HER MAJESTY'S STATIONERY OFFICE
AND SOLD BY
J. D. POTTER, 31 POULTRY, AND 11 KING STREET, TOWER HILL;
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STANFORD, CHARING CROSS.

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Gr. Brit. Meteorol. Office.

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REPORT

OF THE

Second Meeting of the International Meteorological Committee.

COPENHAGEN, AUGUST 1882.

Protocol of the First Meeting, 1st August 1882.

THE MEETING was opened in the "Hydrographic Office" at 10h. a.m.

Present: MM. Wild (President), Buys-Ballot, Hann, Mohn, Neumayer, and Mr. Scott (Secretary).

The PRESIDENT welcomed those members who were present, and stated that two members, viz., MM. de Brito-Capello and Mascart, had been prevented from reaching Copenhagen in time for the first Meeting, but that they would come as soon as possible, and would probably be present at the next meeting. He further stated that M. Cantoni had been prevented by illness in his family from attending the present meeting, and that he would at a later period lay before the Committee the correspondence which had passed with that gentleman, and which contained a proposal made by him.

The PRESIDENT proposed that M. Hoffmeyer, as the host of the Committee, should be invited to attend its meetings.

Mr. SCOTT drew the attention of the Committee to the Resolution of the First Meeting at Berne, in which the terms of admission of non-members were defined. He recommended the Committee not to establish a precedent which might produce inconvenience in future.

M. NEUMAYER agreed with Mr. Scott as to the latter reservation, but was of opinion that, in the present instance, in accordance with the President's proposal, the invitation of M. Hoffmeyer, as the host of the Committee on the present occasion, could not give rise to any inconvenient precedent.

It was accordingly resolved unanimously to invite M. Hoffmeyer to attend the present Meetings.

The PRESIDENT requested the Secretary to read the Programme of questions for discussion proposed by the Executive Officers.

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The Programme was read and adopted with some additional articles, proposed respectively by MM. Hann, Neumayer, and Buys-Ballot. (Appendix I.)

The PRESIDENT requested the Secretary to read his Report Appendix II.), the first point of the business to be considered.

The Report was read and adopted.

It was resolved to have M. Houzeau's letter printed as Appendix XII. to the Report of the Committee.

The discussion was opened on M. Cantoni's proposal to resign his seat on the Committee in favour of M. Tacchini (Article XII. of the Programme). M. Cantoni's letters of the 3rd and 27th July (Appendix III.) were read. The Committee expressed its full concurrence with the President in his regret at M. Cantoni's resignation, as expressed in his reply to that gentleman, and in accordance with the proposal contained in M. Cantoni's letter of July 3, unanimously elected M. Tacchini a member of the Committee.

The discussion was opened on Article VII. of the Programme:—

"The proposed International collection of the systems of storm-warnings, &c. to the coasts of different countries, for the International Fisheries Exhibition in London, 1883."

The letter, dated 8th July, of Sir Brandreth Gibbs, Secretary of the "International Fisheries Exhibition," was read (Appendix IV.).

The Committee resolved, on the proposal of the President, to invite the Directors of Central Offices to send to the Meteorological Office, for the proposed Exhibition, a collection of apparatus and copies of all Instructions referring to the issuing of Weather Forecasts and Storm Warnings to the seafaring community, and also relating to Maritime Meteorology.

The discussion was opened on Article X. of the Programme:—

"Report on the degree of conformity with the decisions of the "Congresses of Vienna and of Rome of the instruments and "methods of observation actually in use."

The PRESIDENT proposed that fresh reports for each country should be asked for, and be printed separately in the Report of the Committee, and not be separated up into various heads, as before, in the case of the Report of the meeting at London.

This proposal was supported by Mr. Hann.

It was resolved that the reports should be asked for and printed, as suggested by M. Wild, the reports to have reference to the 31st December next. Any reports received too late to be published separately.

MM. Hann, Mohn, and Neumayer, were appointed a Sub-Committee to draw up a plan for the Report, and to submit it to the Committee at one of their subsequent meetings.

The Secretary submitted the Report of the Second Intercolonial Conference of Australasia, held at Melbourne the 21st–

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27th April 1881. He was requested to have a summary of this Report printed as Appendix V.

The meeting was adjourned at 12h. 30m. p.m. until 2h. p.m.

A letter from M. Petyt, Vice-President of the Chamber of Commerce of Dunkirk, dated 29th July, was read, asking permission for M. Terquem to attend the meetings of the Committee, as the said Chamber takes a lively interest in the proposed cable to Iceland.

It was agreed to admit M. Terquem on the conditions laid down at Berne.

The discussion was opened on Question VIII. of the Programme (M. Köppen's proposal as to "the symbols for hydrometeors").

M. HANN stated that a French translation of M. Köppen's proposals had been sent to all the members of the Committee belonging to the Latin nations. (Resolution of the Third Meeting at Berne.)

With regard to the First proposal, for alteration of the international symbols, it was agreed, after discussion, not to alter the symbols recommended by the Congress of Vienna, with the exception of the introduction of notice of squalls, by inserting the symbol for "strong wind" beside that for the phenomenon, as "rain" or "snow."

The consideration of the Second proposal was then taken up.

"1°. It is necessary in the interest of climatology, as well as of synoptical meteorology, that precaution should be taken, by suitable alterations in the forms for observation and in the instructions for observers, as well as in the form of publication, for the unequivocal record of the hydrometeors existing at the moment of observation (especially rain, snow, hail, and soft hail). In publication this can be effected by making the columns for the record of cloud observations wider, so that the above signs, together with the exponents 0 and 2, may be able to take a place next to the figure for cloud, if at the time of observation one of the specified hydrometeors existed (in the event of want of space, the most important would suffice). The observer's remarks, the detailed publication of which is very desirable, can be given with advantage, according to Kupffer's method, and as now done in the Annals of the Austrian Central Office, at the side of the tables, where they are not cramped for room.

"With regard to the term 'the moment of observation,' each observation takes altogether a certain time, the observer can only be directed to make a fixed rule for the rotation in which the individual meteorological elements are to be observed, and to refer the estimation of the amount of cloud, together with the statement whether it rains, snows, &c., to a definite specified limit of time. The expression 'Rain in showers,' which is very suitable for the remarks because very characteristic, which is denoted by '*p*' in the Beaufort scale, is therefore of course to be entirely avoided in the notation of the weather at the moment of observa-

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tion, as well as the likewise indefinite expression 'rainy.' These remarks refer, so far as regards the original day-books and instructions, to observers at sea as well as to those at fixed stations."

(*a.*) M. MOHN recommended the adoption of the system already introduced in the Norwegian Annals, for 1880 and subsequent years, viz., to employ the following exponents:—

a morning (between the first and second daily observation).
p evening „ second and third „
n night „ third and first „

Rain or other phenomena, observed at the exact time of any epoch of observation, to be indicated by a symbol entered after the record of the phenomenon which gives the epoch; for instance:—

●[1] Rain at 8h. a.m.
✳[3] Snow at 8h. p.m.

Rain or other phenomena, observed during the interval *between* the epochs of observation, to be indicated by exponents added to the symbols; for instance:

●[on] Light rain during the night.
●[na] Rain during the night, the morning, and at 8h. a.m.

M. Mohn's proposal was adopted.

"2°. It is desirable to introduce as a new element into meteorological summaries for land and sea, an expression for the 'duration of rain' or for the 'absolute probability of rain,' in one of the three forms:—

$$\frac{r}{n}\ \frac{r}{n}N. \text{ or } \frac{r}{n}\frac{N}{d}$$

in which n is the total number of times of observation.
r the number of times of observation with rain.
N the total number of hours in the period under consideration (Month).
d the number of days on which rainfall is noted.

Therefore $\frac{r}{n}$ = the 'absolute probability of rain.'

$\frac{r}{n}N$ = the probable total continuance of rain in hours in the period under consideration.

$\frac{r}{n}\frac{N}{d}$ = the average duration of the rain upon a wet day."

(*b.*) The Committee regretted that it could not recommend the adoption of M. Köppen's proposal as to the probability of rain, &c., because the data for these calculations are not given by observers at Stations of the Second Order, but it recommended observers at Stations of the First Order, and at sea, to consider the possibility of giving this information.

The discussion was opened on Question XVII. of the Programme:—

"The importance of the study of evaporation not only from a free water surface, but also from surfaces of different characters, as, for instance, of sand, of clay, &c."

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The Committee, while recognizing the importance of these researches, was not of opinion that any resolution or recommendation, more precise than those existing, could be framed, as the observation of evaporation generally had not made sensible progress since the Congress at Rome.

M. HOFFMEYER submitted to the Committee a new rotary hygrometer which had been invented by himself and Captain Rung.

The sitting ended at 4h. p.m.

(Signed) H. WILD.

Protocol of the Second Meeting, Wednesday, 2nd August.

THE MEETING was opened at 10h. a.m.

Present: MM. Wild (President), Buys-Ballot, de Brito-Capello, Hann, Mohn, Neumayer, and Mr. Scott (Secretary).

A telegram from M. Mascart was read, announcing that he expected to arrive before noon.

The protocol of the first meeting was read and confirmed.

The discussion was opened on Question XV. of the Programme:—

"The Members of the Committee are requested, if possible, to bring under the notice of meteorologists the results, at least for the period of the International Polar Stations, of observations of stations which do not belong to any meteorological system, and which appear either irregularly or in local publications, and are always difficult to procure. This is particularly desirable for stations situated in the intervals between the existing systems, especially in tropical regions."

After remarks on this subject by different members, it was agreed to issue a circular to the Directors of Central Offices to draw their attention to M. Hann's proposal, inviting them to communicate, for the *Bulletin International Polaire*, a list of distant stations from which observations might be obtained.

The discussion was opened on Question IX. of the Programme.

M. HOFFMEYER stated to the Committee that the Meteorological Office of London had already begun to publish, in the *Daily Weather Reports*, monthly means of Observations taken at Telegraphic Reporting Stations, commencing with the year 1880, as he had indicated in his proposition to the meeting at Berne.

The following was the action on M. HOFFMEYER'S proposal at Berne:—

"In order to draw up the Meteorological Summaries of each day, and to judge of the importance of the atmospheric conditions, as well as their probable consequences, it would be very convenient to have some information, as reliable as possible, on the mean

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values and extremes of the elements of the weather at the stations which serve as a basis for the international and telegraphic meteorological service. The best thing would evidently be to know these data for rather short periods, for instance, for pentades or decades, but the means and extremes even for each month would be of great assistance."

"In the event of your honorable Committee sharing this view, I would venture to request it to take care that the materials necessary for this end were published in a convenient form, either by each individual country, for those stations for which the telegraphic reports relating to the weather are sent abroad, or, perhaps still better, by means of centralisation in one of the Meteorological institutions; and in accordance with communications received from the other Meteorological establishments.

"The Committee adopted the following resolution:—

"The Committee has heard with interest Captain Hoffmeyer's communication, and recommends the Central Institutions to calculate the averages, &c. which he proposes, for the International and Telegraphic stations."

The Committee decided to recommend the Directors to add to their *Daily Weather Bulletins* at the end of each month the monthly means for Telegraphic Stations, according to the example of the Meteorological Office of London.

The discussion was opened on Question XIV. of the Programme:—

"Is it desirable that the number of members of the Committee should be increased, by the addition of certain persons representing other important Meteorological Organizations."

Several members of the Committee were of opinion that it might be desirable to increase the number of members. But it was found that, by the resolution of the Congress of Rome, the Committee was to consist of nine members only. This being a formal obstacle to the proposed augmentation, it was thought that a future Congress could alone make alterations in this direction.

M. NEUMAYER repeated on this occasion a communication which he had already made at Berne, namely, that he had been instructed by the German Government to announce that in the event of any proposal being made to convene a third Congress, that Government reserved its decision as to its participation therein, and that, speaking generally, the German Government was at present of opinion that it would not be desirable to convene a fresh Congress soon.

The meeting was adjourned at 12h. 30m. p.m. until 2h. p.m.

M. MASCART arrived in the meantime, and expressed his deep regret that he had not been able to reach Copenhagen sooner, and to take part in the first meeting, at which the question of the replacement of M. Cantoni by M. Tacchini was brought forward. He stated that he regretted the determination which M. Cantoni had taken, but that he would have readily acquiesced in the

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opinion of the Committee in support of the nomination of M. Tacchini.

The discussion of Question XIV. was resumed, and finally M. Mascart proposed the following resolution: "While considering the extension of the International Committee to be desirable, it does not appear possible to give effect to that desire, on account of the conditions on which the nomination of the Committee by the Congress of Rome took place.' This resolution was adopted.

The discussion was opened on Question XVI. of the Programme:—

"A communication from MM. Hoffmeyer and Neumayer on the subject of the issue of daily synoptic charts and weather reports for the area of the North Atlantic Ocean, and the countries bordering on it."

On the invitation of the PRESIDENT, M. HOFFMEYER made the following communication to the Committee:—

"MM. Hoffmeyer and Neumayer submit to the Committee a plan for the publication of daily synoptic charts of the North Atlantic Ocean and its coasts.

"The plan differs from the analogous scheme which was submitted to the Congress at Rome in so far that the cost of the publication of the charts and explanatory text (*Synoptic Review*) is to be borne by the Danish Meteorological Institute and the *Deutsche Seewarte*.

"MM. Hoffmeyer and Neumayer communicate to the Committee this plan, which is to be considered only as a private agreement between the two institutions above named, with the object of requesting the various directors to kindly assist them with materials, and of eliciting an expression of opinion from the Committee upon the importance of the undertaking.

"The Committee is requested, however, to understand that it is not a question of a resolution of a general nature, but that the gentlemen named hope to be provided by the Committee with a resolution worded in such a way as to indicate the importance of daily synoptic charts for the development of theoretical meteorology and of the practical study of weather. They propose to submit copies of such a resolution, if adopted, to their respective Governments as a justification for the expense of the proposed publication, which will amount to a considerable sum.

The Committee adopted the following resolution:—

"The Committee considers that such a continuation of Captain Hoffmeyer's synoptic charts, as may be anticipated from the proposal of MM. Hoffmeyer and Neumayer, will be of the greatest importance for the progress of dynamical meteorology, and that the publication of daily charts for an extensive area is indispensable for researches into general meteorology and for the improvement of the weather service, not only for the coasts, but also for inland stations. It is accordingly of opinion that the proposal should be actively supported on all sides."

The sitting ended at 4h. p.m.

(Signed) H. WILD.

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Protocol of the Third Meeting, Thursday, 3rd August.

THE MEETING was opened at 10h. a.m.

All the members of the Committee were present.

M. Tietgen was present by invitation of the Committee.

The discussion was opened on Question IV. of the Programme.

M. TIETGEN explained the method which he proposed for carrying out the project of the proposed cable, and promised, in accordance with the desire of the members, to submit his remarks in writing for the Report. (Appendix VI.)

The PRESIDENT thanked M. Tietgen for the trouble he had been good enough to take, after which M. Tietgen withdrew.

The Committee decided, at the suggestion of the President, to divide the discussion into two parts, the scientific question and the mode of putting the project into execution.

The discussion of the scientific part of the question was first taken up.

All the members of the Committee were agreed as to the importance of the undertaking for the purpose of weather prediction, and the following resolution was finally adopted:—

"The Committee, with reference to their former utterances on the subject, consider that storm warnings cannot realize all the advantages which may be anticipated from them until regular telegraphic communications are established with the stations situated to the west of Europe, viz., Iceland, America, and the Azores. The prospect of the establishment of this network does not appear to be near, but the Committee is of opinion that a cable uniting Iceland to Europe would meet the requirements which are most urgent; they therefore recommend such an undertaking, and request M. Hoffmeyer to draw up, for distribution by the executive officers of the Committee, a memorandum which will set forth the general interest of the scheme."

This resolution was adopted unanimously.

The Committee then passed to the consideration of the practical side of the question.

On the invitation of the PRESIDENT, M. HOFFMEYER communicated to the Committee several other considerations, in addition to those expressed by M. Tietgen, and which might possibly facilitate the execution of the project by diminishing its cost.

The Committee decided not to frame any resolution upon this point.

The meeting was adjourned at 12h. 30m. p.m. until 2h. p.m.

The discussion was opened on Question III. of the Programme:—

"The plan for International Meteorological Tables for the reduction of observations."

M. LÉON TEISSERENC DE BORT, who was present by invitation, submitted to the Committee some remarks upon the subject of the reduction of the barometer to sea-level. (Appendix VII.)

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The Sub-Committee elected at Berne (the President and M. Mascart) submitted to the Committee specimens of tables constructed by M. Mascart.

"SCHEME FOR INTERNATIONAL METEOROLOGICAL TABLES.

List of Tables.

I. Conversion of different thermometer scales.
   1°. Reaumur to Centigrade.
   2°. Fahrenheit to Centigrade.
   3°. Centigrade to Fahrenheit.

II. Reduction of the barometer to 32° F.
   1°. French measures.
   2°. English measures.

III. Mutual conversion of English, French (old and new), and Russian measures for the barometer.
   1°. English measures to millimetres, between 19 and 31 ins.
   2°. Millimetres to English inches, between 540 and 780 mm.
   3°. Russian measures to millimetres, between 535 and 615 half lines.
   4°. Russian measures to English inches.
   5°. Old French measures to millimetres.

IV. Conversion of English measures, both for rainfall and evaporation.
   1°. French lines to millimetres, from 0 to 100 lines.
   2°. English inches to „ „ 0 to 100 ins.
   3°. Millimetres to English inches, „ 0 to 100 ins.

V. Vapour tension.
   1°. French measures.
   2°. English measures.
   3°. Boiling point temperatures, between 680 and 800 mm. English and French measures.
   4°. Tensions per 0°·01 near 100°. C.
   5°. Weight of water in saturated air, per 0·1.

VI. Hygrometer.—Abandoned.

VII. Influence of gravity on barometric readings.
   French measures.
   English measures.

VIII. Reduction of the barometer to sea-level.
   1°. French measures, 2 tables.
   2°. English „ 2 „

IX. Reduction of temperature to sea-level.
   1°. French measures.
   2°. English measures.

X. Conversion of kilometres and English miles per hour to metres per second, and *vice versâ*.

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XI. Measurement of heights by the barometer.
  1°. French measures (*a*) Approximate height.
    (*b*) Correction for temperature.
    (*c*) „ „ humidity.
    (*d*) „ „ altitude.
  2°. English measures Ditto.

XII. Conversion.
  1°. English feet to metres.
  2°. French „ „
  3°. Metres to French feet.

XIII. Conversions of English weights (grains) to grammes, and *vice versâ*.

XIV. Conversion.
  1°. Minutes and seconds to decimal parts of an hour, and *vice versâ*.
  2°. Hours and minutes to decimal parts of the day, and *vice versâ*.
  3°. Days to decimal parts of a year, and to arc (1 year = 360°), and *vice versâ*.

XV. Table for calculating the mean direction of the wind by Lambert's Formula.

XV*a*. Table of Natural Tangents.

XVI. Constants for the conversion of magnetic measures.

XVII. Note on electric units."

Mr. SCOTT undertook to have specimens of the tables, with explanations as to their calculation, printed and distributed to Meteorologists in the name of the Committee, together with a circular asking for their opinions thereon.

The discussion was opened on Question V. of the Programme:—"The organization of a Tele-Meteorographic System."

M. CAPELLO submitted two Memoirs to the Committee—

I. On the daily temporary telegraphic connection of the Central Offices. (Appendix VIII.).

II. On the desirability of the organisation of a system of simultaneous observations in Europe for the purposes of weather prediction. (Appendix IX.).

M. BUYS-BALLOT drew the attention of the Committee to the opinions which he had repeatedly expressed as to the importance of the various proposals, which had been submitted to the Committee, to have the readings of the instruments at distant stations recorded at the Central Offices.

The Committee acknowledged the great importance of M. van Baumhauer's and M. van Rysselberghe's ideas, and resolved to request M. van Rysselberghe in particular to publish details as to the carrying out of his plan. The Committee further expressed its opinion that experiments should be made with the various kinds of apparatus proposed.

The sitting ended at 4h. p.m. (Signed) H. WILD.

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Protocol of the Fourth Meeting, Friday, 4th August.

THE MEETING was opened at 9h. 45m. a.m.

All the members were present.

The protocols of the second and third meetings were read and confirmed.

The discussion was opened on Question VI. of the Programme:—

"The observations of atmospheric electricity."

Upon the invitation of The PRESIDENT, M. MASCART gave the Committee some information as to the methods which may be employed for the observation of atmospheric electricity. He stated that the principles were well established, and that various forms of apparatus proposed up to the present time allowed of comparative results being obtained.

The discussion was opened on Question XVIII. of the Programme:—

"A proposal respecting the observation of the upper movements of the atmosphere."

Professor HILDEBRANDSSON was present, by invitation, and communicated to the Committee particulars as to the method proposed by him for the observation of "cirrus" clouds.

Mr. SCOTT informed the Committee that since 1880 regular observations of cirrus clouds had existed in the British Isles, which had been organised by the Rev. Clement Ley, and undertook to distribute among the members of the Committee copies of the instructions actually in use in the British system of observations.

The Committee decided to request MM. de Brito-Capello, Hildebrandsson, and Mr. Ley to prepare a Report on the subject of cirrus observations, to be distributed by the executive officers of the Committee.

The discussion was opened on Question II. of the Programme:—

"The preparation and publication of a general catalogue of observations and meteorological memoirs."

The Report of the Sub-Committee—M. Hellmann and Mr. Scott—was read (Appendix X.). A letter from Mr. Symons, dated 5th July, was also read. (Appendix XA.).

Mr. SCOTT reported that he had already received catalogues of memoirs from the Netherlands and Saxony, and of the publications of the Observatory of the Infanta Dom Luiz.

M. MASCART submitted to the Committee a specimen of the Library Catalogue of the Meteorological Society of France, of which he had made mention at Berne.

The Committee recommended Directors of Central Offices to prepare special catalogues for their own countries, pending the publication of a general catalogue.

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Mr. SYMONS's proposal to have the titles of the publications of the different offices printed and sent out with the books was adopted.

As to the catalogue of Observations, the Executive Officers were invited to issue a circular to Meteorologists calling attention to the resolutions of the Congress of Rome, and of the meeting at Berne, with reference to these catalogues.

The meeting was adjourned at 12h. 20m. p.m. until 2h. 10m. p.m.

The Sub-Committee elected at the first meeting brought forward the Circular which they had prepared for the collection of information as to the different organisations, Point VII. of the Programme (Appendix XI.).

This Circular was adopted.

The discussion of Question XIII. of the Programme was then taken up.

It was agreed to publish the Report of the Committee in three languages, like that of the Berne meeting.

The German edition by M. Neumayer.
„ English „ Mr. Scott.
„ French „ M. Mascart.

These gentlemen respectively expressed their readiness to undertake this duty.

The PRESIDENT thanked the members of the Committee for the attention which they had given to the discussions, and expressed the hope that the second meeting of the International Meteorological Committee would ensure a true advance in Meteorological Science.

The meeting was closed at 3h. 30m. p.m.

(Signed) H. WILD.

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APPENDIX.

APPENDIX I.

Programme.

1. Report of the Secretary on the action of the Committee since the meeting at Berne.
2. The preparation and publication of a general catalogue of observations and meteorological memoirs.
3. The plan for international meteorological tables for the reduction of observations, &c.
4. The definition of the interest to meteorological science in the establishment of telegraphic cables connecting the Azores and Iceland to Europe.
5. The organisation of an international tele-meteographic system :—
   - 5*a*. M. Capello's proposal : The temporary telegraphic connexion of the central offices.
   - 5*b*. „ „ On the utility of simultaneous observations in Europe.
6. The observations of atmospheric electricity.
7. International collection of the systems of storm warnings, &c. to the coasts of different countries, for the International Fisheries Exhibition in London, 1883.
8. M. Köppen's proposal (made at the Berne meeting) as to the symbols for hydrometeors, &c.
9. M. Hoffmeyer's proposal (made at the Berne meeting) respecting the publication of mean values of telegraphic observations.
10. Report on the degree of conformity with the decisions of the Congresses of Vienna and of Rome, of the instruments and methods of observations actually in use (Congress of Vienna).
11. Proposal to invite M. Hoffmeyer to be present at the meetings of the Committee.
12. M. Cantoni's proposal to resign his seat on the Committee in favour of M. Tacchini.
13. The preparation and publication in three languages of the Reports of the meeting, by the executive officers.
14. Is it desirable that the number of members of the Committee should be increased, by the addition of certain persons representing other important meteorological organisations ?
15. M. Hann's proposal : The members of the Committee are requested, if possible, to bring under the notice of meteorologists the results of observations of stations, at least during the period of the International Polar Stations, which do not belong to any meteorological system, and which appear either irregularly, or in local publications, and are always difficult to procure. This is particularly desirable for stations situated in the intervals between the existing systems, especially in tropical regions.
16. A communication from MM. Hoffmeyer and Neumayer on the subject of the proposed issue of daily synoptic charts and weather reports from the area of the North Atlantic Ocean and the countries bordering on it, as already discussed at the Congress of Rome and the meeting at Berne.

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17. M. Buys Ballot proposes to direct the attention of meteorologists to the importance of the study of evaporation not only from a free water surface, but also from surfaces of different characters, as, for instance, of sand, of clay, &c.

18. Proposal respecting the observations of the upper movements of the atmosphere :—

1°. A committee should be nominated to draw up simple instructions for the observations of clouds. These observations should he made at a certain number of suitable stations. The instructions should be limited to the following observations:

(1.) The movement of the lower clouds.
(2.) The movement of upper clouds, or cirrus.
(3.) The direction of the radiant points of cirrus clouds.

2°. Full observations of cirrus are earnestly recommended by the International Meteorological Committee. For the present, however, these observations should be taken only by observers specially interested in these difficult studies. Before commencing the observations it is necessary that the nomenclature should be perfectly definite, and the phenomena to be observed strictly determined.

APPENDIX II.

REPORT of the SECRETARY upon the WORK of the COMMITTEE since the MEETING at BERNE.

The Report of the Berne Meeting has been published in three languages, the English edition in 1881; the German and French editions at a later period.

As to the resolutions of that meeting:—

(i.) The International Polar Committee held a meeting at St. Petersburg in August 1881. The expeditions, in number, 13 for the Northern, and 2 for the Southern Hemisphere, sent out by the different countries taking part in the undertaking, have already started for their respective destinations. It is to be hoped that most of the expeditions have by this time commenced taking their observations, and that the others will begin during the current month.

Thus the undertaking, notwithstanding the lamented death of its originator, presents a very favourable prospect of being fully realised.

The officers of the Committee have forwarded the Bulletin which they have published, as a report of their operations.

(II.) M. Hoffmeyer's proposal as to the publication of monthly means for international and telegraphic stations has not received the attention which it deserves. Possibly the present meeting could, by a special circular, invite meteorologists to consider this important question.

III. M. Köppen's proposal, as to the publication of information about hydrometeors, has hardly been brought under the notice of meteorologists, except by publication in the *Zeitschrift* of the Austrian Meteorological Society.

Is it desirable to take any steps at present in the direction indicated by the resolution of the Berne meeting?

I have the honour to submit to the Committee, the following list of documents which have been received since August 1880.

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A. M. Houzeau's report on the conformity of methods, &c. in Belgium to the decisions of the Congress of Vienna.

B. Report of the sub-committee (M. Hellmann and Mr. Scott), on the preparation of a general meteorological catalogue.

B*a*. A letter from Mr. Symons on the same subject.

B*b*. Lists of published meteorological memoirs from—

1. The Netherlands.
2. Portugal.
3. Saxony.

C. The report of the Second Intercolonial Conference of Australasia, held at Melbourne 21–27 April 1881.

D. A proposal by M. de-Brito Capello for the introduction of simultaneity in the observations for the telegraphic service in Europe.

E. A proposal by M. de-Brito Capello for the temporary telegraphic connexion of the Meteorological Institutes.

F. The Committee of the International Fishery Exhibition requests the International Meteorological Committee to organise for that Exhibition a complete series of the different systems which exist for the communication to Fishermen of information about the weather.

G. A letter from M. Buys Ballot, dated 11th February 1882, on the "Telemeteorographs" of M. Olland and M. van Rysselberghe.

H. M. Neumayer has informed the Committee that the Great Northern Telegraph Company has undertaken to send the telegrams for the Polar Expedition *gratis* as far as Stromness; and Mr. Scott has stated that the London and North-Western Railway Company and the Grand Trunk Railway Company have also kindly consented to forward the baggage of the British Expedition *gratis*.

(Signed) ROBERT H. SCOTT.

APPENDIX III.

SIR, Rome, July 3, 1882.

I HAVE been obliged to delay considerably this reply to your very obliging invitation to the next meeting of the International Committee at Copenhagen owing to the long and serious illness of my wife. I am in hopes of a speedy improvement, but I am sure that it will not now be possible for me to go to Copenhagen.

I should regret exceedingly that Italy should not be represented at this important meeting of the International Committee. For this reason I venture to request, sir, that you will consent to the substitution of Prof. P. Tacchini, the Director of the Central Meteorological Office of our kingdom, in my stead.

He is better acquainted than I am with the conditions and requirements of our meteorological service, and he is by his position at the head of the science in our country.

I therefore request you to admit him instead of me at this meeting, and also that he may be permitted to replace me in future on the International Committee.

I shall be obliged by a word in reply.

Accept, &c.

Dr. H. Wild, (Signed) G. CANTONI.
President of the International Meteorological Committee,
St. Petersburg.

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SIR, Varese, July 27, 1882.

I REGRET that the delay in my communicating to M. Tacchini your letter of the 13th instant, owing to my absence from Rome, will prevent him from reaching Copenhagen by the 1st August next, especially as he has to settle several urgent matters, and among others, business connected with the new observatory upon Mount Etna.

I beg, however, sir, that you will induce the other members of the International Committee to accept my proposal to resign my seat upon that committee in favour of M. Tacchini.

I thank you for your courteous letter and beg you to accept, &c.

(Signed) G. CANTONI.

Prof. H. Wild,
President of the International Meteorological Committee,
Copenhagen.

APPENDIX IV.

The GREAT INTERNATIONAL FISHERIES EXHIBITION, LONDON, 1883.

SIR, London, July 8, 1882.

I HAVE the honour to forward to you herewith a copy of a Resolution passed at a meeting of the Executive Committee of the Great International Fisheries Exhibition, London, 1883, and to ask your kind assistance in carrying through the object desired.

I have, &c.

(Signed) B. F. BRANDRETH GIBBS,
Director and Secretary.

To R. H. Scott, Esq., M.A., F.R.S.,
Meteorological Office,
116, Victoria Street, S.W.

"THAT Robert H. Scott, Esq., M.A., F.R.S., Secretary to the Meteorological Council, be asked to bring the Great International Fisheries Exhibition, London, 1883, to the notice of the International Meteorological Committee at their meeting in August next, at Copenhagen, with the view of urging the members to arrange for a combined international representation at the said Exhibition of Storm Warnings, and of the mode of giving weather intelligence to fishermen."

APPENDIX V.

REPORT of the SECOND INTERCOLONIAL CONFERENCE, held at MELBOURNE April 21–27, 1881. (Abstract.)

The Conference was attended by the same gentlemen as on the previous occasion of its meeting, viz.: Messrs. Ellery (Victoria), Hector (New Zealand), Russell (New South Wales), and Todd (South Australia).

It was reported that neither Queensland, Tasmania, nor West Australia, had appointed representatives to take part in the Conference.

Mr. R. J. Ellery, F.R.S., was elected President.

The proceedings opened with the reading of reports by the different members on the action taken in their respective colonies to carry out the resolutions of the Sydney Conference of 1879.

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Special reports were then read on the subjects referred to the members at that meeting, viz.:—

1. Shade temperature.
2. The sling thermometer.
3. Hygrometry.
4. Anemometry.
5. Solar radiation.
6. Evaporation.

(1) and (2.) Comparisons between the sling thermometer and various thermometer screens had been made by Messrs. Todd, Russell, and Ellery. Mr. Todd preferred an open wooden screen, Mr. Russell had employed the Greenwich screen, and Mr. Ellery had used a special screen, a shed of galvanized iron with a double roof, and stated that the results he obtained therewith agreed very well with those of the sling thermometer.

(3.) *Hygrometry.*—Mr. Russell alone reported on the employment of maximum and minimum thermometers for the psychrometer.

(4.) *Anemometry.*—Mr. Ellery communicated the results of comparisons between Hagemann's and Robinson's anemometers, and expressed his general approval of the former. Mr. Russell submitted a specimen of a hand anemometer he had devised for use at his telegraphic reporting stations.

(5.) *Solar radiation.*—No definite recommendations were made.

(6.) *Evaporation.*—Mr. Russell exhibited a sketch of the atmometer in use at Sydney, with a table of the results obtained therewith.

Resolutions were adopted tending to consolidate the system of intercolonial weather service. The coast lines of the south and east of Australia were divided into several districts, and the interior into two, for the purpose of telegraphy to New Zealand. A word code, like that in use in the United States, was preferred to the figure code in use in Europe.

The Conference finally referred most of the questions, on which reports had been presented, for further and fuller consideration.

The Appendix to the Report contains the names and geographical co-ordinates, with the altitudes, of the stations at which complete and regular observations are made. These are distributed as follows:—

New South Wales -	29
New Zealand - -	15
South Australia -	13
Victoria - -	14

APPENDIX VI.

Proposal for a Telegraphic Cable to the Faroë Isles and Iceland.

Sir, Copenhagen, August 4, 1882.

You have done me the honour of asking, in the name of the International Meteorological Committee, for a statement in writing of the remarks which you were good enough to allow me to make orally to the Committee upon the question of the establishment of telegraphic communication between Iceland and Europe; an undertaking which has occupied my attention for some years past.

The following is that statement:—I propose that the cable should start from Thurso and should be carried to the Faroë Isles and to Berufjord, and Reikianæs in Iceland, and that stations should be established at these three places;

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That the communication between the two last places should be established by submarine cable and not by an ordinary wire, owing to the difficulty of repairing interruptions in a country which is almost without roads and is very thinly populated;

That the cables should be very strong in order to protect them against tides and currents.

The carrying out the project, on these conditions, would cost about 200,000*l.*, and as the commercial and private messages would not cover at most more than the cost of working the cable, the sum necessary for interest, repayment of principal, and repairs, should be contributed by the Governments interested in obtaining the important addition to the existing daily meteorological observations, which it would be the object of the undertaking to provide.

I estimate that for these expenses an annual sum of 10 per cent., or 20,000*l.*, would be required, and I propose that this amount should be provided by the different countries, in proportion to their extent, population, and the importance of their navigation, &c., in the form of a subscription for 20 years and for three meteorological telegrams daily, but charged at a rate varying according to the proportion above mentioned, the countries being classed in three lists, for example:—

1st List.	2nd List.	3rd List.
Denmark.	Russia.	Holland.
England.	Germany.	Sweden.
France.	Norway.	Portugal.
		Austria.

and fixing the tariff of the 1st list at 3*l.*,
„ „ 2nd „ 2*l.*,
„ „ 3rd „ 1*l.*,
per telegram, which would amount to,—

3 × 3 × 365 × 3*l.*	=	£9,855
3 × 3 × 365 × 2*l.*	=	6,570
4 × 3 × 365 × 1*l.*	=	4,380
Total		£20,805

or for each country in the 1st list 3,285*l.* per annum.
„ „ 2nd „ 2,190*l.* „
„ „ 3rd „ 1,095*l.* „

I think that the scheme would be more easily realised, upon the basis I have just indicated, than upon that of a fixed annual subvention, because the countries or meteorological offices have only to contribute according to the number of telegrams that they receive, and the negotiations can be taken up with each Government separately, instead of the realisation of the undertaking being made dependent on the adoption of a general agreement as to all the essential points among the different countries interested.

I venture to hope that the Meteorological Committee, which is already convinced of the great scientific importance of this undertaking, as has been expressed at several previous Conferences, will recommend to their respective Governments the carrying out of the scheme, with such modifications as they may find desirable.

Accept, &c.
(Signed) C. J. Tietgen.

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APPENDIX VII.

On the Reduction of the Barometer to Sea-level.—Importance of the Exact Determination of the Co-efficient of Decrease of Temperature with Height.

The reduction of the barometer to sea-level is an operation, the object of which is to furnish us with a term for comparing pressures observed at different heights.

If the temperature and its mode of decrease in the air were constant, the operation would be much simplified, because, on rising by any given amount, we should again find readings which differed very little between themselves, and these differences could easily be calculated, allowing for the initial pressure.

Thus the differences which might exist between the reduced readings would no longer be attributable to the reduction, but would depend upon dynamical effects and the arrangement of the isobars.

But in the atmosphere, the temperature varies with the geographical position, and its mode of decrease changes from one point to another. It results that for equal heights, while starting with the same pressure, the variation of the pressures is very different, owing to the different temperatures in the strata of the atmosphere.

This inequality of the temperatures, which influences the density of the strata of air at the different points under consideration, greatly complicates the solution of the problem. In order to study more easily what takes place in the atmosphere, it is necessary to employ a graphical reproduction of the arrangement of the curves of equal pressure. Suppose that the curves of equal pressure assume in the atmosphere the lines indicated by the following figure:—

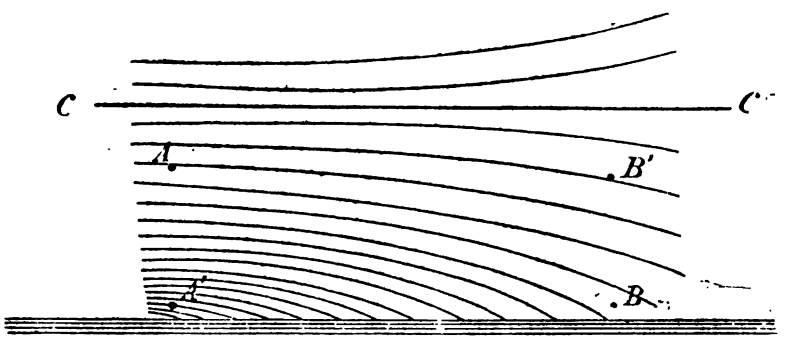

Fig. 1.

Suppose we have observed, at the point A., in a balloon, a pressure P. which we wish to compare with the pressure at the point B, situated at the sea-level. If, by former experiments, we know the value of the decrease of temperature from A to the sea-level, we could determine by means of this co-efficient and of the temperature observed at A, the mean temperature of the stratum of air A A′, and consequently we could calculate exactly the pressure at A′ and its difference from B.

The gradient between A′ and B will be thus determined by means of the pressure at A. In this case, the reduction of the pressure to sea-level is an operation which corresponds to a real fact, and may in a certain measure take the place of the direct observation at A′.

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But its accuracy depends mainly upon the accuracy with which we know the mode of decrease of temperature between A and A′, not taking into account dynamical disturbances.

§ I. Barometrical observations made on continents.—Suppose now that with the same arrangement of the curves of level, the elevation of the ground be such (Fig. 2) that the point A, instead of being in the atmosphere, be situated on a continent, so that the portion A A′ B, instead of being occupied by air is filled up by the ground.

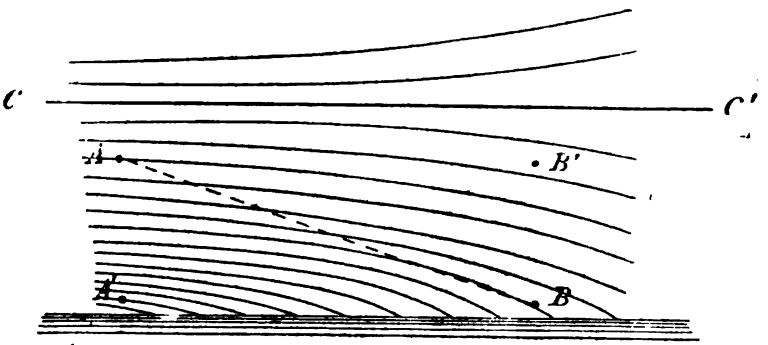

FIG. 2.

In this case, we assume, for reducing the pressure to the level of the sea, that the atmosphere is continued below A as before, and the calculation of the reduction is done in the same way; but it is seen immediately that it is a numerical operation which does not correspond to a real fact; as M. Hann has so well said, it is a fictitious reduction. We must therefore ask what is the value of the gradient thus obtained.

As we may observe, by continuing the atmosphere in a theoretical way, we augment the differences of pressure; it may be seen, in fact, that the curves in the real part of the atmosphere are more open, since they approach each other towards A A′. Now their distance apart depends upon the gradient, on the variation of temperature towards the interior of the continent, and on the slower decrease of temperature. These three causes, which increase from B B′ to A A′, act upon portions of the atmosphere becoming less and less considerable in proportion as we approach A, while in our reduction they are supposed to act on this entire column of air with the intensity that they have at A A′. The calculated weight of the column is therefore superior to the weight of a column of the same length and composed of air at the actual density of the atmosphere.

In fact, what puts the air in motion in the lower strata are the differences between the horizontal pressure, existing near the ground, in the successive layers of air extending from A to B. Let us imagine in fact, this space from A to B divided into a series of vertical sections. A small mass of air, M, placed in one of these sections, tends to pass into the adjacent couche by the difference of pressures existing between them at the same height; now we can express this difference of pressure by an equation.

In fact by ascending as far as the curve of same pressure C C′, let P be the pressure at CC′ and l the distance from CC′ to the point where the little mass m is situated.

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The pressure of the column m, or P′, will be expressed by :—

$$\text{Log } P' = \text{Log } P - \frac{l}{A + nl + Kt}.$$

The pressure PP′ at the same height in the adjacent column is expressed by :—

$$\text{Log } P'' = \text{Log } P = \frac{l}{A + nl + Kt'}.$$

The difference between the two gives the infinitely small gradient which tends to push m towards B′ B.

In its movement towards B, when the little mass m gets a little lower, the infinitely small gradient will be given by the difference between two analogous expressions, where l will become l', and the temperatures t'' and t'''.

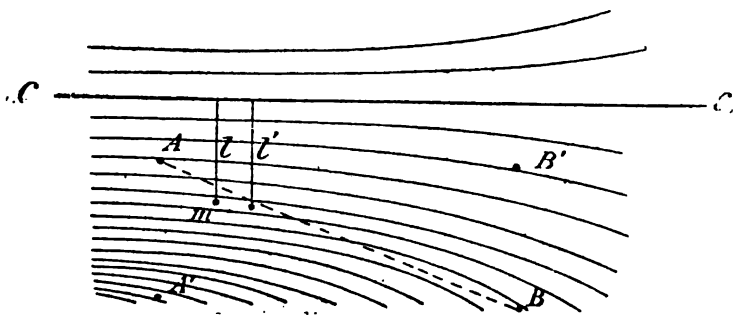

FIG. 3.

It is the sum of these differences which, in the movement of the air from A towards B, represents the horizontal force which tends to carry the air towards B. Now it is well to remark that the sum of these successive differences is equal to the total difference between the two stations which represents the numerator of the gradient when the air rests upon a horizontal surface.

In the other cases it is made up by the difference of the pressures at A′ and at B and the difference of the pressures at A and at B′.

If we wished, by a method of this kind, to calculate the gradients, it would be necessary to know as exactly as possible, the co-efficients of the decrease of temperature.

§ II. In order to avoid what is fictitious in the usual reduction, we might calculate the difference of pressure in another way, and find what the pressure is above B at the same height as A, that is at B′; the comparison of the observed and calculated values would give the gradient. M. Hann in his "*Zeitschrift für Meteorologie*," for 1879, p. 82, has shown the advantages of this method. Although this method has the great advantage of corresponding to a real fact, for the difference of pressure between A and B′ really exists, yet it cannot be substituted, in a general way, for the theoretical method in use for studying the circulation of the atmosphere at the earth's surface. If this increases the gradients, the other diminishes them to a considerable extent, and may even completely suppress them.

In the example that we have chosen, let us suppose the point A to be near to CC′, the differences between the pressures near this curve will be very small at the same height, the gradient calculated will be very slight, and might even be nothing if the point A were nearer to CC′,

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while between A and B the inflexion of the curves of level indicates to us a very appreciable difference of pressure, and there is no doubt that between these two points there would be a current of air in the direction from A to B.

Now the arrangement of the lines of level which we have taken as an example explains the circulation of the air between the continents and the oceans during winter, and it is therefore not an arbitrary example.

Finally, whether we wish to employ the usual method, whether we wish to adopt the principles indicated in paragraph 1, or, whether we employ the method explained by M. Hann, it is indispensable that we should know pretty exactly the co-efficient of the vertical decrease of the temperature of the air.

It seems to me that experiments should be made upon this point; M. Wild, for instance, admits in Russia a decrease of 1^{0} for 260 metres in winter, in France we usually adopt 1° for 200 metres as a co-efficient for the cold months. Is that due to a different method of discussing temperature observations, or to the fact that the decrease of temperature is usually different in Russia?

If we have to draw isobars over large areas we do not know what coefficient to adopt for intertropical countries; it is very likely that the co-efficient for the summer months is that which suits them generally, but the high table-lands, like Mexico, have a rather marked winter, so that perhaps the co-efficient of decrease in such cases should be that of winter.

Certain localities, like St. Helena, afford data showing that the decrease may be as much as 1° per 100 metres* for several entire months.

The variation in the co-efficient of decrease varies also from one day to another, and the evidence of recent winters has drawn attention to the frequency of inversions of temperature.

It appears to me therefore, that with the precision which meteorological science gains from day to day, the study of the decrease of temperature with height, in different countries and under different atmospherical conditions, is of great importance for the extension and accuracy of all our isobaric charts, for the calculation of gradients, &c.

Accordingly I venture to call the attention of the International Meteorological Committee to the following propositions:

1°. The co-efficients to be employed for the calculation of the mean temperature of the stratum of air in the reduction to sea-level are not known sufficiently accurately for different regions, and for the various conditions of the atmosphere, to enable us to indicate them in the international tables.

2°. Investigations made in this direction on table-lands, mountains, and in balloon ascents, are especially recommended.

3°. The manner in which the temperature has been calculated for the reduction of the barometer should be indicated in Meteorological memoirs.

4°. The Committee should recommend the publication in daily or monthly bulletins of the observations of mountain stations, with the addition of the pressures reduced to sea-level.

These observations, in fact, possess great interest, because they teach us something of what is going on in the upper regions of the atmosphere. The reduction of the pressures to sea-level, especially if the temperature at the base of the mountain is observed, may give curious results, so far as regards the study of dynamic phenomena.

(Signed) LÉON TEISSERENC DE BORT.

* See "*Zeitschrift für Meteorologie*," 1879, page 403.

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APPENDIX VIII.

On the Temporary Daily Telegraphic Connexion of the Central Offices.

M. Buys Ballot's proposal is without doubt the ideal and true system of meteorological connexion, as everyone would acknowledge. But I am afraid that the initial outlay would for some years prevent the adoption of such a beautiful and complete system. Pending the introduction of such a system, I have the honour to submit for the consideration of the International Committee a more modest proposal, which, although not presenting such advantages, or aiming so high as the former, might, however, render good service.

All neighbouring countries are connected by several international lines of telegraph. Between Portugal and Spain there are five such lines. I think it would be quite possible to obtain direct connexion between neighbouring central offices, for a certain time each day, during the slack hours of telegraphic business.

The directors of central meteorological offices, with the consent of the directors of telegraphs, or of their respective Governments, might easily arrange for one of the international lines to be placed at their disposal say for 30 or 40 minutes; during this time they might communicate directly the state of the weather and the latest evening reports from stations previously agreed upon, together with any matters of interest. To effect such a connexion it would only be necessary to erect a sufficiently powerful battery at each central observatory; and if in a more or less distant future, telegraphic communication becomes more easy and certain, this is doubtless the method which should be employed. It appears to me that the realisation of this plan will not present great practical difficulties, in so far as regards continental offices. It would be of great advantage for the prediction of weather and especially for warnings of bad weather or storms, when depressions advance suddenly.

(Signed) J. Capello.

Observatory of the Infanta D. Luiz,
18th July 1882.

APPENDIX IX.

On the Desirability of the Organisation of a System of Simultaneous Observations in Europe for the Purposes of Weather Prediction.

Would it be desirable to organise such a system of simultaneous observations in Europe?

The utility of simultaneous meteorological observations for the study of the formation and propagation of atmospherical disturbances is not disputed by meteorologists. The United States of America were the first to make use of this system of observations on a large scale, and the great progress of weather prediction in America is without doubt due to this method of observation.

There is no need, therefore, to demonstrate that it is only by means of simultaneous observations that we can learn the real form of the isobars, and represent by this means the atmospheric depressions, their centres and motions.

Every one admits that the isobars are subject to rapid transformations, especially when they assume an elliptical shape. In the centres of these

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curves the alternate fall and rise of the barometer, and above all, the variations of the wind, are very rapid, and this may lead us into serious errors, if the observations are made at different epochs.

For the last five or six years simultaneous observations, once a day, synchronous with the 7h. a.m. observation of the United States, have been made at the principal observatories of Europe and at several stations; but these observations, which are published at the expense of the Signal Office, although of great value in the study of meteorology, do not serve, nor can they serve, for the prediction of weather in Europe. The observations for this service are made with us at local time, and this local time is different in different countries.

Correspondence with the United States' system of simultaneous observations, whatever be the hour chosen from the three daily epochs (7, 3, and 11, Washington time), appears to me unsuitable for the European service of weather prediction.

Hence it is necessary to establish an independent system.

The difficulties are well known, and they may be reduced to two principal classes:—

1°. The necessity of changing one of the hours of observation at all observatories and stations. Such a change is always unpopular, and at certain stations is carried out with difficulty.

2°. The choice of a suitable hour for the observation, so that it may not be inconvenient for the western stations, on account of being too early, nor for the eastern stations, on account of being too late in the day, which would make it difficult to transmit the meteorological reports by telegraph.

The western countries are doubly ill-used by meteorology. Their observations must be taken at more inconvenient times, and, on the other hand, they cannot be forewarned of the storms or depressions coming from the ocean. These countries are able to warn eastern countries, and the latter, while they receive the warnings from the former in useful time, are not obliged to take simultaneous observations so early.

This subject is important for the progress of Meteorology, and it would be proper to see if the difficulties are insurmountable, or if it would be possible to reduce them to a minimum.

In the first place, we should inquire whether it would be possible to reduce the number of stations for the study of weather prediction. M. Buys Ballot mentions 50 leagues (250 kilometres) for the mean distance between the stations. There is no doubt that the position of the observatories or stations is more important than their number, or even than the distance between them.

If it is possible to diminish the number of stations, especially those to the east, the work of telegraphy would be reduced.

With respect to the time of the First Meridian that should be adopted, it appears to me that it would be convenient to choose an hour near that actually in use at the western stations, say 8h. a.m., Paris time, during the whole year. In this case the change of hour would not be very great for the most westerly stations. The Portuguese and Irish stations would take their observations after 7h. a.m., Valencia, at 7h. 9m. a.m., Lisbon, 7h. 14m., Corunna, 7h. 18m., and Funchal, being at present the most western station, at 6h. 43m. a.m. The English and Scotch stations between 7h. 20m. and 8h. a.m.; the Norwegian and Swedish stations between 8h. and 9h. a.m., as well as a large part of France, Germany, and Italy; Austria, and a part of Russia between 9h. and 10h. a.m.; the latest would be Moscow and Archangel, at about 10h. 20m. a.m.

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These last hours would be inconvenient for telegraphic transmission, but on the other hand, the observations from the western countries, which are the most necessary for the prediction of weather, would be transmitted more rapidly if they were generally taken earlier than they are when local time is employed.

If meteorological telegrams were considered by all telegraphic directors as service telegrams, that is if they always had precedence, the objection of inconvenient hours would no longer exist. I think this subject is one of the points to which the directors of central offices should give their attention.

The objections as to the inconvenience of hour in the western countries are, perhaps, more serious, and more difficult to be overcome. For instance, the time of observation at Funchal (6h. 43m. a.m.) during winter is too early. The difficulty would be greater at the Azores, if these islands were connected telegraphically; but in this case an observatory would be established in the group with a more skilled and numerous staff than the present observers.

Let us now see whether it would be advisable to connect the European simultaneous observations with the three hours of the United States system, for the study of probable weather. In this case it would be necessary to completely modify our system of weather prediction; this would have to depend upon the night observations instead of day ones.

The most convenient Washington time would be 3h. p.m., which corresponds to 8h. 18m. Paris time. For other countries the hours would consequently be advanced by 18 minutes, but this would take place in the evening instead of the morning. In the most eastern countries the hours would fall later at night, up to 10h. 37m. at Archangel.

As far as telegraphic transmission is concerned, the proposed system would, perhaps, be more convenient, for the wires would be freer in the afternoon than during the morning hours. The weather forecasts drawn during the night could be sent to the morning newspapers, which could publish them together with the weather report.

The 11h. p.m. observation (Washington time) would be very inconvenient in consequence of its being too early; it would correspond to 3h. 31m. a.m. for Lisbon, and to 4h. 18m. a.m. for Paris.

From all these combinations we may conclude that the existing hours of the American system do not appear to suit for Europe.

All of these considerations are not new, the subject has been already discussed; but it appears to me that it is now time to reconsider this question of simultaneous observations for the daily service of weather predictions.

I admit that this question cannot be solved by the International Meteorological Committee, but I submit it for the consideration of the directors of central offices and observatories, in order that it may be studied in all its bearings, and that it may be decided whether the advantages of a simultaneous system do not exceed its disadvantages.

(Signed) J. CAPELLO.

Observatory of the Infanta D. Luiz,
18th July 1882.

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APPENDIX X.

Report on the proposed Meteorological Bibliography.

London and Berlin, June 1882.

The under-mentioned Sub-Committee elected by the International Meteorological Committee at their fifth meeting at Berne on the 11th August 1880, for the further consideration of the question of the preparation of a general Meteorological Bibliography, had, in accordance with the proceedings of the above-mentioned meeting, the special task of taking the necessary measures for the preparation of the proposed work on a uniform plan, in accordance with the requirements of the programme, in case the Meteorological Office of London might possibly be able to undertake the printing *gratis*.

As, however, the Meteorological Council, at its meeting of the 12th January 1881, decided that it could not defray, from the vote of its Office, the cost of the technical preparation of the Meteorological Bibliography and as, also, it was clear from previous reports and deliberations upon this subject, that at the present time the realisation of the plan was not practicable, either by means of subscriptions or as an ordinary publishing venture, the Committee were henceforward obliged to take up an expectant attitude, and could only undertake to induce the Directors of the various Meteorological systems to publish special bibliographies for their respective countries.

Under existing circumstances this appeared to be the surest way to attain the desired end, as the preparation of a general bibliography of Meteorology could naturally be effected with comparative ease by a single expert at the cost of the publishers, if such individual bibliographies existed for the most important countries or languages.

We were confirmed in this opinion by our experience gained during the preparation of such a special work for Germany. It was then shown that this could only be done in the country itself, with access to a great library, and with the co-operation of almost all the large libraries of the country, or else the results would be very defective and imperfect.

The Sub-Committee is in the fortunate position of being able to report some progress and some results in the direction of local bibliographies.

Under the direction of M. H. H. Hildebrandsson, an alphabetically arranged index, containing the Swedish Meteorological publications for the last 35 years, from 1856 to 1881, has been published by M. C. G. Fineman, in the "Nordisk Tidschrift" for 1881, and has also been separately printed. It contains the names of 61 authors, and about 170 titles of works.

The Brussels Observatory, whose library has been considerably increased during the last few years, is preparing a second edition of its catalogue published in 1878, which will be of great use for the above-mentioned purposes.

In the same way the catalogue of the "Deutsche Seewarte" at Hamburg, which will probably be sent to press in the beginning of the year 1883, will prove very useful.

Mr. Sohncke has published in the Seventh and Twelfth Annual Reports of the Central Station at Carlsruhe, two lists of meteorological works and treatises, relating to Baden.

By the completion of Riccardi's *Biblioteca Matematica Italiana*, Modena, 1870–1880, a good foundation has been laid for Italy.

The only comprehensive special meteorological bibliography (including terrestrial magnetism) of whose partial completion the sub-committee has cognizance, is that being prepared by Dr. Hellmann for Germany, which will also comprise a catalogue of observations, &c., &c.

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The work, of which a printed-off sheet is appended for inspection*, will probably appear next October under the title "Repertorium of "German Meteorology. Contributions by Germans of pamphlets, "Inventions, and Observations, in the Domain of Meteorology and "Terrestrial Magnetism, from the earliest times until the year 1881." The first part (Bio-Bibliography) contains about 12,000 titles, distributed between about 2,000 authors. These figures, in comparison with those formerly estimated as the probable number for the aggregate work of the general bibliography (32,000 titles), clearly show the necessity of distributing the work in the way above mentioned, if the whole should possess such a completeness and finish as it is desirable, and is also possible to attain. Independently of the efforts of the International Meteorological Committee towards the production of a General Meteorological Bibliography, although only indirectly promoted by them, it appears from statements by Mr. Symons (Monthly Meteorological Magazine, February 1882) to be the intention of the Chief Signal Officer of the United States, General Hazen, by combining the extracts made by Prof. Cleveland Abbe from the Royal Society Catalogue and the M.S. Catalogue of Meteorological Works collected by Mr. Symons, and also by making use of other available materials, to publish a preliminary General Bibliography of Meteorology.

Whether, and how far the support promised in this work by individual members of the committee meeting at Berne with respect to the bibliography proposed by the Congress will be asked for, is unknown to the sub-committee. The sub-committee think, however, that they should in the first place hold to the views above expressed, and strive to obtain special bibliographies for the different countries, but are of opinion that the intended work by General Hazen is "acceptable as "a working index, and a first contribution towards the exhaustive "work that is desired," and that the carrying out of the plan, if possible, should receive every support.

(Signed) ROBERT H. SCOTT.
G. HELLMANN.

To M. H. Wild,
President of the International Meteorological
Committee, St. Petersburg.

P.S.—It should also be mentioned that the Meteorological Society (London) has already published as a supplement to the Seventh Volume of its "Quarterly Journal" an "Index to the Publications of the English Meteorological Societies, 1831 to 1881." We have the honour to annex a specimen of the Appendix XX. to the "Annual Report of "the Meteorological Council," which appears yearly,† and which contains a catalogue of the additions to its library during the year.

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* Specimen of Dr. Hellmann's Catalogue:—
Abendroth, William. Dr. phil. Prof. d. Math. u. Phys. a-Gymn. zum heiligen Kreuz in Dresden (or), geb. 1838, Juli . . . Pirna.
Ueb. die opt. Erscheinungen in d. Atmosphäre. Jahresb. ver. Erdk. Dresden XV., 1878, p. 40.

† Specimen of Meteorological Office Catalogue:—
A—AGRICULTURE AND BOTANY.
Ritter, C.—Influence des forêts sur les nappes liquides souterraines et sur pluie. 22 pp. 8°. Paris, 1880.

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APPENDIX XA.

62, Camden Square, London, N.W.,
July 5, 1882.

DEAR MR. SCOTT,

I SHOULD be greatly obliged by your calling the attention of the Permanent Committee to the fact that many of the Meteorological Institutes have not yet followed the example of the English Meteorological Council and of the Bureau Météorologique de France, by giving upon the cover, or at the end, of each of their publications a list of all their previous works. Such lists would be useful to everybody (1) as check lists by which the completeness of the series received by each can be verified and (2) because then each individual publication will serve to acquaint scientific men with much of what has been published by each Office.

In the catalogue which I am preparing for the United States Government the absence of these lists will undoubtedly reveal itself prejudicially, though I am doing my utmost to avoid omissions.

I regret also to notice that in many countries the acknowledgment of "books received" is printed in a very incomplete manner. The titles need not perhaps be printed *in extenso* (though personally I should prefer that being done), but the author's name, the place of publication, and the date should always be stated.

The following proposal would, I think, save much time and trouble and ensure greatly increased accuracy.

Along with each published work let there be enclosed three copies of its title, so printed as not to occupy more space than 4 in. by 2 in. (10 c.m. by 5 c.m.). These slips should be used as follows :—

(1.) Should be gummed on a card and would be ready for addition to the catalogue of each institute receiving the work.

(2.) Should be put ready for forming the list of "books received."

(3.) Would be available for the formation of a *subject* catalogue should the receiving institute have established one.

I will send in a few days specimens of what I have above proposed.

Yours, &c.

R. H. Scott, Esq., M.A., F.R.S. (Signed) G. J. SYMONS.

Robertson, Dr. H.—A General View of the Natural History of the Atmosphere, and of its connection with the Sciences of Medicine and Agriculture; including an Essay on the Causes of Epidemical Diseases. 2 Vols.

8vo. *Edinburgh*, 1808.

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APPENDIX XI.

Circular. St. Petersburg and London,
31st December 1882.

SIR,

THE information respecting the meteorological organisations of the different countries which have hitherto appeared in the reports of the Permanent Committee, or of various individual central offices, are too scattered, and are not sufficiently uniform in their arrangement to allow of easy and satisfactory reference.

The Committee are of opinion, therefore, that a general summary of the present condition of the organisations should be prepared, and printed in their Report.

In order to ensure the accuracy of the summary, it is necessary to request the central offices to furnish the necessary information. These communications will be printed in the General Report as nearly as possible in their original form.

It appears to the Committee that it is desirable to append to their request for this information a form for the entries, and they recommend the under-mentioned form for adoption :—

I. General definition of the meteorological system.
II. Number of stations of the First, Second, and Third Order, and especially of the stations of First Order, with their geographical position.
III. The organisation of the stations of the First, Second, and Third Order, the hours of observations, indication of the instructions to the observers, of the tables for reduction employed, and the check to which the observations are subjected.
IV. The special observations, *e.g.*, thunderstorms, hail, periodical phenomena, the return of the seasons, and a statement of the number of stations.
V. Observations at sea.
VI. The organisation of the telegraphic weather service.
VII. The central office of the system; the subordinate stations; their organisation, supply of instruments, &c.
VIII. The staff, their pay, and that of the observers if there is any.
IX. The publications of the central office and the independent publications of the principal stations.
X. The management and inspection of the stations belonging to the system.
XI. Any remarks which may complete the replies already given.
XII. A short historical summary of the system.

The Committee have decided that the replies should refer to the year 1882. Any replies not received before the 1st April 1883 cannot be included in their Report.

We desire to draw the serious attention of Meteorologists to this important subject, and beg you to be good enough to let us know at what date the reply to this circular may be expected.

For the International Meteorological Committee,

H. WILD,
President.
R. H. SCOTT,
Secretary.

To_____

NOTE.—In the replies to this circular it will be noticed that none have been received from the Chief Signal Office, Washington, the Central Meteorological Office, Calcutta, or from the British Australian Colonies.

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Replies to Circular.

AUSTRIA-HUNGARY.

A.—*Dr. J. Hann, Central Office for Meteorology and Terrestrial Magnetism, Vienna.*

Definition of system.

1. The system consists of volunteer observers under the superintendence of a central office maintained by the State. The number and positions of the stations depend therefore, to a certain extent, upon chance, viz., upon the willingness of new observers to undertake the work. If an observer dies or leaves the station, the observations are generally interrupted.

Number and positions of stations.

2. There are 11 stations of the First Order,
„ 128 „ Second „
„ 94 „ Third „

Total 233 stations.

The stations of the First Order are:—

Eger, 50° 5′ N. lat., 12° 22′ E. long., height 1,493 feet, (with only a self-registering barometer).

Cracow, 50° 4′ N. lat., 19° 57′ E. long., height 722 feet, (with baragraph, thermograph. and anemograph).

Kremsmünster, 48° 4′ N. lat., 14° 8′ E. long., height 1,260 feet, (with barograph, thermograph, and amenograph).

Lesina, 43° 11′ N. lat., 16° 27′ E. long., height 75 feet, (with barograph, thermograph, and anemograph).

Lemberg, 49° 50′ N. lat., 24° 0′ E. long., height 978 feet, (outfit in course of being supplied).

Lobositz, 50° 31′ N. lat., 14° 3′, E. long., height 528 feet, (with thermograph).

Summit of the Obir, 46° 30′ N. lat., 14° 27′ E. long., height 6,713 feet (with thermograph, barograph, also anemograph in future).

Pola, 44° 52′ N. lat., 13° 50′, height 105 feet (with barograph, thermograph, anemograph, and sunshine recorder).

Prague 50° 5′ N. lat., 14° 25′ E. long., height 659 feet, (with barograph, thermograph, anemograph, and self-recording rain-gauge).

Trieste, 45° 39′ N. lat.,. 13° 46′ E. long., height 118 feet (with barograph, thermograph, and anemograph).

Vienna, 48° 14′ N. lat., 16° 22′ E. long., height 664 feet. (See below.)

Organisation of stations.

3°. Second Order. Kappeller's cistern barometers, with immoveable cistern, dry and wet bulb thermometers, rain-gauges; a few only have special wind vanes.

Third Order. Thermometers and rain-gauges.

The hours of observation are mostly 7h., 2h., and 9h. The instructions are Jelinek's "*Anleitung zu den meteorologischen Beobachtungen*," 2nd edition (Engelmann, Leipzig). A special correction card is supplied with each cistern barometer, in which the corrections for temperature and altitude are combined. For Humidity Tables, those by Wild, issued by Jelinek, are used.

Special observations.

4°. There are none. Since the death of Fritsch, the phenological observations have not been discussed.

Marine observations.

5°. There are none. These will perhaps be organised at the Observatory of the Nautical Academy at Trieste.

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6°. This is attended to by a telegraphist and by an assistant of the Central Office. Daily weather charts are drawn and published. In the summer half-year weather forecasts are published for the benefit of agriculture. The telegrams are allowed a reduction of 50°/₀ on the ordinary tariff. The cost per month is about 19*s.* Weather telegraphy.

7°. The Central Office of the system is at Vienna and is entitled "*K K Central-Anstalt für Meteorologie und Erdmagnetismus.*" The instrumental outfit is stated in the Year-book of the Central Office for the year 1875, Vol. XII., New Series. The Central Office.

The following observations are regularly reduced and published in the Year-books:—Temperature, pressure, wind-direction and velocity, sunshine (in addition to the elements of terrestrial magnetism).

Since April 1872, the observatory of the Central Institute has been situated to the north of the town on a small height surrounded by a garden. The Central Institution serves as a central observatory and a central depository for the observations of the whole system, where they are reduced, calculated and published. The central observatory does not possess any filial stations, unless some of the astronomical observatories and schools can be considered as such, but these are independent of the Central Institute.

8°. A director (salary 280*l.* and addition of 48*l.*, with an advancement of salary to 320*l.* and 360*l.* after five years and ten years service respectively.) At the same time he is Professor at the University with the duty of giving lectures in meteorology and physical geography. There is, however, no salary or remuneration for this. Free apartments are provided for him in the building of the Institute. The staff.

Three adjuncts, with salary of 140*l.*, and addition of 36*l.*; after each five years service an advancement of 20*l.* is made. Two of the adjuncts have free apartments in the building of the Institute.

One assistant with salary of 70*l.* and free apartments.
Three computers at 4*s.* a day each.
Three servants, one of whom is only employed temporarily.
One man to attend to the photographic manipulation of the magnetographs, the current mechanical work and the heating.

The total grant to the Central Institution for salaries, outfit of instruments, attendance, &c., amounts in round numbers from 2,400*l.* to 2,800*l.*

The observers receive no remuneration, except those on the summit of the Obir and the Schafberg in winter, and the Schmittenhöhe (at the Zellersee), amounting altogether to 30*l.*

9°. The Central Institute publishes a "Year-book" annually, which contains the daily observations from 18–19 stations, the monthly and yearly results of all the other stations, and the tabulations of the self-recording instruments of the central observatory. Publications.

The stations of Klagenfurt, Trieste, Pola, Prague, and Cracow, publish their observations separately.

10°. The system is managed by the Central Institute in Vienna; the whole of the stations are inspected once every six years by the staff of the Central Institute. The amount voted yearly for this purpose, viz. 30*l.*, is not sufficient for the inspection of all stations; so that only the principal stations can be visited. Management and inspection.

11°. Since the year 1871, the Hungarian countries (Hungary, Transylvania, Croatia, and Slavonia) have had an independent system, managed by the Central Office at Buda-Pesth. Supplementary Remarks.

12°. The Austrian system was established in 1848 by the Imperial Academy of Sciences of Vienna. To M. Kreil, the first director, and Baron von Baumgartner, vice-president of the Academy and afterwards Historical.

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Minister of Finance, the principal merit for the promotion of the system is due. The scheme for a meteorological service for the Austrian Monarchy will be found in the "*Sitzb. K. Akad. math.-naturw. Classe,*" Vol. I. for the year 1848, Section II. Part 3, p. 58, &c., (Vienna 1848).

The Central Office for Meteorology and Terrestrial Magnetism was established in 1851, and commenced operations in September 1852 in a house rented in Favoritenstrasse, Vienna, as a central observatory, and continued there until April 1872, when it was transfered to the new building the "Hohe Warte," situated on the north of the town. The Year-books were first published by the Imperial Academy in 8 vols. for the years 1848–1856 (the first vol. was for 1848–9), then a separate publication was issued by the Academy under the title, "*Witterungs Übersichten,*" covering the years 1857—1863, which appeared as a supplement to the *Sitzungsberichte.*

From the year 1864 a new series of the "*Jahrbücher*" was begun by M. Jelinek in a form somewhat smaller than that of the first series. This publication has been published complete up to the year 1879 inclusive, and in addition the first sections for the years 1880 and 1881 have appeared.

B.—*Dr. R. Müller, Hydrographical Office, Pola.*

SIR,

I HAVE the honour to reply to the questions contained in the circular of the International Meteorological Committee, dated 31st December 1882, as regards the station at Pola.

Definition of system. 1°. Austrian system.

Number and position of stations. 2°. Station of the First Order, 44° 51′·8 N., 13° 50′·8 E. of Greenwich.

Organisation of stations. 3°. One Fortin's barometer by T. L. Kappeller as a standard barometer.

One siphon-barometer by Fuess, as a check barometer.

One Wild's electrical registering balance-barometer by Hasler and Escher.

One electrical registering aneroid-barometer by Hipp.

One electrical registering thermograph (dry and wet bulbs) by Hasler and Escher.

One Kew standard thermometer.

One electrical registering thermograph by Hipp.

One dry and wet bulb thermometer.

One recording thermometer by Negretti and Zambra.

Several maximum and minimum thermometers by T. L. Kappeller.

Solar maximum thermometers (black, white, and ordinary bulbs) by Kappeller.

Terrestial radiation thermometer by T. L. Kappeller.

One hygrometer.
One storm glass.
One universal hygrometer.
One weather compass.
} all Klinkerfues'.

One Campbell's sunshine recorder.

One atmometer by Höttinger and one by von Lamont.

One Robinson's self-registering anemometer.

One electrical registering anemometer.

One registering wind-vane.

One registering rain-gauge.

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Three rain-gauges (two in the courtyard and one on the roof).
One ozonometer on Dr. Lender's principle.
One tide-gauge.
Two Seismometers.
Two Hipp's clocks and one pendulum-clock for driving the registrating apparatus.

For magnetic observations:—
One declinometer.
One bifilar magnetometer.
One von Lamont's theodolite.
One Jones's magnetometer (under repair).

The regular, direct, meteorological observations are made in the same way as those at the Central Institute, viz., at 7h. a.m., 2h., and 9h. p.m.; at noon also barometer and thermometer readings are made, and the recording thermometer turns over at 2h. a.m.

The direct observations, to serve as standards for the measurement of the curves of the self-recording instruments, are checked at least during the day-time by the head of the department, or by his subordinate officers; the double set of self-recording instruments check each other. Jelinek's tables are used for the reduction of the observations.

4°. The formation and course of thunderstorms are observed as far as practicable. Special observations.

Phenological observations, in a strict sense, are not made.

5°. Regular tidal observations, both direct, as well as by means of tide-gauges. Marine observations.

Meteorological observations are occasionally taken on board ship (beyond the few which are prescribed for safe navigation).

6°. At 7h. am., pressure, wind direction, and force, amount of cloud, readings of dry, wet, maximum and minimum thermometers, rainfall and state of the sea are telegraphed to the Central Office. Weather telegraphy.

From Vienna and Trieste daily weather telegrams arrive for Austro-Hungary, Germany, and the stations on the Adria, as well as the isobar telegrams for Europe.

The station at Pover on the southern point of Istria telegraphs its meteorological observations every morning.

The contents of all these telegrams as well as our own observations are published every morning.

7°. Hohe Warte, Vienna. The Central Office.

8°. The meteorological service is performed by the observatory branch of the Hydrographic Office. This Office, which includes the following branches, observatory, chart depôt, depôt for nautical instruments, and maritime library, is under the superintendence of the above-named director; and the departments in question are under Hydrographic Officers. The staff.

To the chief of the observatory branch (at present temporarily conducted by a naval officer) are assigned one or two naval officers, mostly for the period of a year and a half, also a retired warrant officer as assistant.

The above persons receive fixed salaries.

9°. Monthly and yearly results of observations. These are published in the "Mittheilungen aus dem Gebiete des Seewesens" drawn up by the Hydrographic Office, and are also sent to various institutions and stations, 41 at home and 40 abroad. Publications.

10°. Maintained by the Admiralty. Management.

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C.—*Dr. Guido Schenzl, Royal Hungarian Central Office for Meteorology and Terrestrial Magnetism, at Budapesth.*

General Definition.

Definition of system.

1. The Royal Central Office of Hungary is intrusted with the investigation of the climatological and magnetic conditions of the kingdom (including Croatia). Some years ago the Royal Ministry of Agriculture established a special weather office and published daily weather charts and forecasts. The Central Office is only connected with that institution in so far as the latter makes use of the telegraphic reports which are sent to the Central Office. The task of observing, with the exception of the forest meteorological stations and the rain stations mentioned below, is voluntary and without pay, but the instruments are supplied *gratis* by the Central Office.

Number and positions of stations.

2. There are three stations of the First Order :—

	Height above sea.
1. Budapesth, lat. 47° 30′, long. 36° 42′ from Ferro	502
2. Fiume „ 45° 17′ „ 32° 7′ „	76
3. Agram „ 45° 49′ „ 33° 39′ „	535
Stations for the Second Order in 1882	100
„ „ Third „ „	36
„ „ Fourth „ „	3

Organisation of stations.

3. Outfit of stations of the First Order. *Budapesth.*—In addition to the instruments for regular observations, viz., barometer, dry and wet thermometers, and raingauge, there are in use one Kreil's barograph, one Lamont's thermograph, one Höttinger's self-recording rain-gauge, one Robinson's anemometer. For magnetic observations only the instruments for declination and horizontal intensity are erected, owing to want of space.

The station at Fiume possesses, besides the instruments for stations of the Second Order, van Rysselberghe's universal meteorograph for registering the readings of barometer, thermometer, and hygrometer, direction and force of wind, and rainfall, and also a Seismograph.

The station at Agram possesses, in addition to the ordinary instruments for stations of the Second Order, a self-registering barometer and thermometer by Hipp, an anemograph with printing type, and a raingauge by Otto Schaffler, of Vienna (Osnaghi's pattern), an anemograph by E. Schneider of Vienna, and a Wild's atmometer.

The Agricultural Society of Neutrathal (situated at Nedanócz, lat. 48° 36′, long. 35° 5′, height 507 feet), takes a special position in the system, as, for the purpose of its own agricultural-meteorological objects, it has formed a subsidiary meteorological association. It consists of three stations of the Second Order and one of the Third Order, which also belong to the Central Office, and, in addition, it has 31 stations of the Second Order, which have no connexion with the Central Office. A special service of forecasts is established at the central station of Nedanócz; the warnings are made known by a semaphore.

The outfit of the stations of the Second Order consists of a cistern-barometer by Kappeller, reading to 0·1 mm., dry and wet bulb thermometers ($\frac{1}{5}$° C). one rain-gauge and one wind-vane.

The stations of the Third Order have the same instruments as those of the Second Order except the barometer.

The stations of the Fourth Order only observe rainfall, and, at the special wish of the observer, they receive a thermometer. The number of these stations had increased to 40 at the end of last year.

Hours of observation.—The regular hours of observation are 7h. a.m., 2h., and 9h. pm. Some of the older observers have kept to the hours

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formerly in use (prior to 1870), 6, 2, 10; others chose other combinations, *e.g.* 8h., 1h. 8h., a drawback which cannot be helped, in cases where the observers are volunteers.

The instructions used are Dr. C. Jelinek's "Anleitung zur Anstellung meteorologischer Beobachtungen." A short introduction in the Hungarian language gives the necessary explanation to those observers who are not acquainted with German.

The instruments are verified by the Central Office before being issued. The tables for barometer reductions are calculated from Jelinek's formula for Kappeller's station barometers (page 146 of the first edition). The constant errors, which very seldom reach 0·2mm., are not allowed for in the tables, but are applied to the means. For the deduction of vapour tension and relative humidity the tables by Wild and Jelinek are used.

4. Special observations of thunderstorms and hail are not made. Phenological observations are made at 14 stations, and the results are published in the yearbooks. A copy of the form for observations is appended. (Not printed here.) Special observations.

5. Nothing is known of these at present. Marine observations.

6. The Central Office receives daily telegraphic reports of the state of the weather at 7h. am. from 21 home stations. The telegrams are composed according to the following code:— Weather telegraphy.

$$BBBWW \quad SHTTT \quad T_1T_1T_1RR.$$

B = Barometer reduced to 32° F.
W = Wind direction
H = State of the sky
T_1 = Wet-bulb thermometer.
S = Windforce.
T = Dry-bulb thermometer.
R = Rainfall.

The reduction of the pressure to sea-level is calculated by the formula:—

$$\text{Log } B = \frac{h}{18382\,(1+0\cdot002\,[T+t])\,(1+0\cdot00265\cos 2\varphi)} + \log b$$

To assist in weather predictions the barometer readings reduced to sea-level are posted up, the observers receive special tables for this purpose.

7. The Central Office is at Buda-Pesth, on the right bank of the Danube. Its operations may be divided into two principal heads. The Central Office.

(*a.*) The establishment, management, and control of the stations, collection and collation of the observations which are received monthly, and correspondence with other central offices.

(*b.*) The work of the meteorological and magnetical central observatory. With reference to (*b*) it must be remarked that the institution does not possess a special building, but since its foundation in 1870, it has been located in a building of very limited dimensions, and all the apparatus which ought to be in operation at a central observatory could not be erected. In addition to the instruments already mentioned under point 3 the following may also be specified.

1 Standard siphon-barometer by Salleron; 1 standard barometer by Fuess, for verifications; several Fortin's and siphon barometers and aneroids; standard thermometers by Dr. Geissler and Fuess, various maximum and minimum thermometers; evaporators on Lamont's, Greiner's, and Wild's principles; solar radiation thermometers and actinometer, various hygrometers on Schwaekhöfer's, Regnault's, and Saussure's principles.

The following instruments are in use for absolute observations:— 1 Lamont's declinometer, and 1 declinometer with collimator by Meyerstein, 1 intensity-theodolite by Lamont, a dip-needle by John Dover, and

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an earth-inductor by Meyerstein, the whole permanently fixed in houses free from iron. The institution possesses magnetic travelling theodolites by Lamont and Meyerstein, 1 mounted transit instrument, and an equatorially-mounted refractor, several spectroscopes, 1 alt-azimuth free from iron, several reading theodolites, 1 box and 3 pocket-chronometers, an analytical balance by Gambey, a standard metre by Ricker, and other apparatus. There are two sets of earth thermometers, but they are not used for observations.

The staff.

8. The staff of the institution consists at present of a director and two observers, one of whom is a "Privat Docent" at the University. The two observers—one of whom lives at the institute—share the daily work of taking three observations of the meteorological and magnetical instruments, as well as the preparation of the monthly reports for the Year-book. The director undertakes the absolute magnetic observations, the correspondence with the stations and the authorities, the comparison of instruments, the routine and other duties.

The regular salaries are at present—

Director, 210*l.*, with quinquennial increment of 20*l.*

I. Observer, 115*l.*, quinquennial increment of 10*l.*, and residence.

II. Observer, 115*l.*, quinquennial increment of 10*l.*, and 20*l.* for lodging money.

In addition there is one servant employed.

For payment of the telegraph messenger and remuneration of the observers (teachers, telegraph employés, &c.) the sum of 100*l.* is included in the estimates.

Publications.

9. The observations of the stations are published in the year-books by the Central Office; up to the present time nine yearly volumes (1871—1879) have appeared. These contain, in addition to the meteorological results in the prescribed form, magnetical and phyto-phenological observations. In addition, the original observations

(*a*) of Buda-Pesth,
(*b*) of Fiume,

are published monthly.

Management and inspections.

10. The management of the stations and the keeping of the whole of the instruments in proper order, and seeing that they exist, is the duty of the director.

The instruments are, with few exceptions, procured at the cost of the Central Institution or of the Royal Hungarian Office, and remain the property of the same. For this purpose the sum of 200*l.* is included in the estimates every year. The stations are inspected by the Director. From 10—30 stations are visited, according to circumstances, and the instruments compared.

Supplementary remarks.

11. In addition to the publications already mentioned, the following have been published by the Central Office: (1) Contributions to the Meteorology of Buda-Pesth; also printed separately in the Hungarian language. (2.) Meteorological and Magnetical Atlas of Hungary prepared on the occasion of the Geographical Exhibition at Venice, and containing 26 charts. (3.) Contributions to terrestrial magnetism in the countries of the Hungarian Crown. Absolute Determinations of the Magnetic Elements at 126 Stations in the years 1864—1881, by Dr. Schenzl, published by the Royal Hungarian Society of Natural Science.

Historical.

12. The history of the Royal Hungarian Central Office will be found in the first volume of the Year-book; I shall only mention the most important points here.

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Meteorological observations were made in Hungary in the last century. We find among the stations of the *Societas Palatina* in the year 1781 Ofen (Buda) already represented.

In the present century we find fragmentary observations—those at the observatories then existing at Erlau, Klausenburg, and Carlsburg (Transylvania), partly made by private persons. The longest series were made at the observatory at Ofen, with a few interruptions, from November 1781 till the destruction of the observatory in May 1849, at which time many registers were lost. The observations made by the astronomer Dr. Lambert Mayer and his coadjutor F. A. de Montedegó, from 1841 to 1848 were published by the Hungarian Academy of Sciences. The Central Meteorological Institute established in the year 1851 at Vienna formed the central point about which numerous observers from Hungary, Transylvania, Croatia, and the Military Frontier soon gathered. Their number increased to 31 in the year 1860. A great falling-off took place in consequence of the political movement in the year 1861, which lasted until the year 1863, and the number of observers in Hungary sank down to 11.

In the year 1861 the undersigned established an observatory at the Ofen *Realschule*, which included observations of the magnetic variation in addition to those of atmospherical phenomena. This was afterwards made the Academic Observatory, and was provided by the Academy with complete magnetical and some astronomical apparatus. The interest which the Academy took in the scientific investigations of the country caused a continually growing interest in the subject of meteorology, and the number of observers rose to 44 in the year 1869. All these sent their observations, for the want of an institution at home, to the Austrian Central Office.

When the Hungarian Constitution was again restored, in 1867, the arrangement which had existed until then could not continue, therefore the Royal Hungarian Ministry of Worship and Instruction, on the proposal of the Academy, resolved to establish an independent Central Office for the countries of the Hungarian Crown ; the Royal Sanction was obtained on the 8th April 1870. The conditions at that time were not favourable for the development of the new institution ; it received a severe blow in February 1871 by the death of its founder, the Minister Baron Eötvös.

Although in the scheme for the organisation of the staff, a director, one adjunct (meteorologist), two assistants, and an auxiliary staff which could be increased when necessary, were provided for, it has not hitherto been possible to obtain the appointment of another assistant, although the number of stations has increased fourfold since the foundation of the institution. That the Central Office, under such conditions, is not in a position to undertake special investigations, beyond the current and actually indispensably necessary observations, is evident. A considerable increase of work is thrown upon the Central Office by a large portion of the observers not reducing and calculating their own observations, but leaving this to the Central Office. The want of a suitable building for special meteorological observations has already been mentioned.

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BELGIUM (*a*.)

M. Houzeau, Royal Observatory, Brussels.

Definition of system.

1°. The meteorological system of Belgium is under the superintendence of the Royal Observatory of Brussels, where all the observations are centralised, reduced, and published.

Number and positions of stations.

2°. It is composed of one station of the First Order, the Royal Observatory, lat. 50° 51′ N., long. 4° 22′ E.. with 40 stations of the Second Order, and 39 stations of the Third Order. The Administration *des Ponts et Chaussées* has also established 122 rain stations, from which the registers are sent to the Observatory and are published by it. The thunderstorm stations number 72, but among these are a large number of stations of the Second and Third Orders which have included the systematic observation of thunderstorms in their programme.

The Résumé,—There are 41 stations which observe atmospheric pressure, temperature, and humidity, with the direction and force of wind.

80 stations observe the amount of cloud and occasional phenomena, with general remarks about the state of the weather.

202 stations observe rainfall.

72 stations systematically observe thunderstorms.

Organisation of stations, &c.

3°. The hours of observation everywhere are 8h. a.m. and 1h. p.m. Rainfall is only observed once a day, at 8h. a.m. At the Brussels Observatory the hours of observation are naturally more frequent; complete observations are made at 9h. a.m., noon, and 0h. 26m. p.m. (The synchronous observation), 3h. and 9h. p.m.; temperature is also observed at 10h. a.m., 2h. and 4h. p.m.

Printed instructions issued by the Observatory are supplied to all observers; they contain the necessary reduction tables. The observations are checked by annual inspection of the stations, and by the examination, at Brussels, of the registers as they are received from the observers.

Special observations.

4°. Phenological observations have been somewhat neglected in recent years, but they are to be resumed shortly. Three or four stations only still pay attention to this kind of research.

Marine observations.

5°. For nearly two years (1879 and 1880) observations were made on board the Belgian mail-packets running between Ostend and Dover, but these have been abandoned. Latterly complete stations of the Second Order have been established on the lightships of Westhinder and Wielingen off Ostend and Flushing. These stations work in a regular manner.

Weather telegraphy.

6°. The Observatory receives the following telegraphic reports daily for the construction of its meteorological bulletin:—

1°. 3 Belgian stations: Furnes, Maeseyck, and Arlon.
2°. 4 Dutch stations, from Utrecht.
3°. 9 French stations, from Paris.
4°. 5 English stations, from Hamburg.
5°. 8 German stations, from Hamburg.
6°. 5 stations for northern countries, from Hamburg. Occasionally we receive from Amsterdam reports from two or three English stations. Lastly, we receive, directly from the "New York Herald" Office in London, the storm-warning notices issued by that journal.

The Observatory, on its part, sends daily telegrams to Paris, London, and Hamburg; and in this country to seaports and fishing stations.

(*a*) See also App. XII., p. 115.

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When a rapid fall in the barometer manifests itself, warning telegrams are also sent to the Administration of Mines.

The Central Office, &c.

7°. Neither the Central Institute nor the Royal Observatory has any branch offices; an observatory is now being established at the University of Liége for astronomical and meteorological researches, but this establishment will be quite independent of the Brussels Observatory. The latter has naturally always in reserve a certain number of instruments for stations of the Second and Third Orders, such as barometers, thermometers, rain gauges, &c.

The Observatory possesses a collection of the following self-registering instruments :—

1°. Van Rysselberghe's electrical meteorograph.
2°. „ telemeteorograph (in operation between Ostend and Brussels).
3°. Photographic self-recording instruments, Kew pattern (for meteorology and magnetism).

All these instruments work regularly.

The staff.

8°. The staff of the system is composed of professors, teachers, clergymen, engineers, agriculturists, manufacturers, &c. These persons are not remunerated.

The staff at the Observatory for meteorological service comprises :—

		£	£
1 Chief of service	salary	200 —	240
1 Meteorologist, Inspector	„	140 —	180
1 Meteorologist	„	140 —	180
1 Adjunct	„	100 —	120
1 Assistant	„	48 —	96

Publications.

9°. The essentially meteorological publications of the Observatory are :—

1°. *The Annales* (comprising the observations made at the Observatory and at all the stations).
2°. The meteorological bulletin (weather charts).
3°. The curves of van Rysselberghe's self-registering apparatus.

Some observers at the stations of the Second Order publish abstracts of their observations in the newspapers of the localities in which they live.

Management and inspections.

10°. As above stated, all the stations, with the exception of those established by the *Ponts et Chaussées*, are under the superintendence of the Royal Observatory. They are inspected every year.

Supplementary remarks.

11°. A great number of particulars relative to the organisation of the meteorological service in Belgium have already appeared in the various Reports of the Congresses or the International Meteorological Committee (*see* Appendix XII. to this Report). These particulars are only intended to complete them.

Historical.

12°. The organisation of the present meteorological service dates from the year 1877. It has been extended and developed each year.

The late M. Quetelet had organised a system of several stations, the observations of which have been published in the memoirs of the Belgian Academy. But the control of the Observatory over these stations was not sufficiently direct. The majority, however, were carried on by educated and conscientious observers.

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DENMARK.

Captain N. Hoffmeyer, Danish Meteorologial Institute, Copenhagen.

Definition of system.

1. The Danish meteorological system embraces the kingdom of Denmark, the Faroe Islands, Iceland, and Greenland. It is organised and managed by the Danish Meteorological Institute, which is a Government institution, under the Ministry of Marine.

Number and positions of stations.

(2.) 1 Station of the First Order:—

Vamdrup in Jutland, lat. N. 55° 25′, long. E. 9° 18′.

Stations of the Second Order:—

Denmark.	Faroe Islands.	Iceland.	Greenland.	Total.
10	1	5	5	21

Stations of the Third Order:—

171	7	18	10	206

Organisation of stations.

3. At the station of the First Order (Vamdrup), pressure, temperature, humidity, and the direction, and force of wind are observed every two hours; the maximum and minimum temperature and rainfall, once daily. The stations of the Second Order observe all the ordinary meteorological elements three times a day (8 a.m., 2 and 9 p.m.) The stations of the Third Order generally observe temperature and rainfall; some of them observe temperature only, and others only rainfall. Observations of wind, weather, sea disturbance, and floating ice are made at 28 lighthouses five times in the 24 hours.

The Instructions which are supplied to the observers are not published. The reduction tables used are those by M. Jelinek. The observations are carefully checked before calculation, and the results are finally compared by the construction of diagrams and of mean synoptic charts for each month.

Special observations.

4. There are no special observations.

Marine observations.

5. Maritime observations are made regularly at 17 fixed stations (lightships, &c.) in the seas surrounding Denmark, and include, besides the meteorological elements (at four-hourly intervals), the direction and rate of currents, the temperature and specific gravity of the sea at the surface, and at different depths down to the bottom.

The Institute also receives a large number of maritime observations made by vessels traversing the North Sea, and the northern parts of the Atlantic, on the voyages to Iceland and Greenland. These observations are entered into squares of one degree of latitude by one degree of longitude.

Weather telegraphy.

6. The Institute receives telegrams every morning containing the 8 a.m. observations from 10 of its own and from 26 foreign stations. Synoptic charts are drawn for the previous evening and for the morning, and show the variations of the elements. At 1h. 30m. p.m. a report of the actual state of the weather in the North of Europe and the probable weather for the next day is drawn up. This report is sent to the newspapers of the Capital, and is transmitted by the Government to all the telegraph stations of the country, where it arrives before 3 p.m.

The Central Office.

7. The Central Institute of the system is at Copenhagen, and there is no filial institution.

The principal instruments belonging to the Institute consist of 45 barometers, 910 thermometers of different kinds, 112 rain gauges, 120 hydrometers, and 31 anemometers. A considerable number of the instruments used at the stations are private property, and these are not included in the above list.

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8. The staff of the Central Office is composed of :— The staff.

1 Director, salary 224*l.* and apartments.

3 Sub-Directors (for climatology, weather telegraphy, and ocean meteorology), salary 112*l.* to 128*l.*

1 Librarian, salary 32*l.*

Computers, Draughtsmen, &c., 220*l.*

All the observers at stations of the Second Order (both in the kingdom and the colonies) receive at least 7*l.* a year, and the observers at the maritime stations get from 2*l.* to 3*l.* a year. Captains of vessels are recompensed in various ways by presents of aneroids, telescopes, publications, &c.

9. The Institute publishes :— Publications.

(*a.*) Daily Weather Charts (a small number is produced by the manifold process, but they are published by the newspapers).

(*b.*) Very detailed monthly reports, with diagrams and mean charts.

(*c.*) Annals.

The publications (*b.*) and (*c.*) are supplied free to all the observers.

10. In the kingdom itself the stations of the Second Order are inspected every year by one of the staff of the Institute; the stations of the Third Order are inspected in turns. In the colonies the stations are inspected by vessels of war, as opportunities present themselves. The Institute possesses sketches and descriptions of all the stations. Management and inspections.

11. No remarks to add. Supplementary remarks.

12. Meteorological observations have been made at Copenhagen since the middle of the 18th century, under the auspices of the Royal Society of Sciences. In 1861 the Royal Agricultural Society organised a system of meteorological stations all over the country, several of which are still in existence. The Meteorological Institute was established in 1872, and from that time the number of stations in the kingdom has gradually increased, and at the same time many stations have been established in the colonies (Faroes, Iceland, and Greenland). The maritime observations were first commenced in 1879. Historical.

FRANCE.

Professor E. Mascart, Central Meteorological Office, Paris.

1°. Central Meteorological Office, under the Ministry of Public Instruction.

2°. Stations of the First Order :— Definition of system.

Park of St. Maur, lat. 48° 48′ 28″ N., long. 0° 0′ 36″ E., alt. 152 feet (Paris.) Number and positions of stations.

Nantes, lat. 47° 13′ N., long. 3° 53′ W., alt. 136 feet.

Puy-de-Dome (two stations)—

Station on the plain, lat. 45° 46′ N., long. 0° 45′ E., alt. 1,273 feet.

Summit of the mountain, lat. 45° 47′ N., long. 0° 37′ E., alt. 4,813 feet.

Pic du Midi, lat. 42° 56′ N., long. 2° 12′ W., alt. 9,377 feet.

Perpignan, lat. 42° 42′ N., long. 0° 34′ W., alt. 98 feet.

The observatories of Lyons and Bordeaux are both meteorological and astronomical, and possess self-recording instruments.

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A private station, St. Martin de Hinx, established and superintended by M. Carlier, possesses a complete set of self-recording instruments, and may be considered as a station of the First Order.

The observatories of Marseilles and Toulouse make observations six times a day, and possess some self-recording instruments.

There are 73 stations of the Second Order, at normal schools, 43 of which make six observations, and 30 three observations daily.

There are more than 1,500 stations of the Third Order, at which rainfall is observed.

In addition there are 16 stations of various kinds.

Organisation of stations.

3°. The staff of the stations of the First Order consists of a director, two assistants, and one attendant.

The hours at which direct observations are made are generally 6 and 9 a.m., noon, 3, 6, and 9 p.m.

The stations of the Second Order observe at the same hours, or at 6h. a.m. noon and 9h. p.m.

The stations of the Third Order generally observe at 9h. a.m.

The Instructions supplied are those published by the Central Office in the form of a pamphlet.

The observations are checked on their arrival at the Office, and are compared with each other. Doubtful or erroneous observations are at once notified to the observers.

Special observations.

4°. Observations of thunderstorms are made at a great number of stations (about 3,500).

The telegraphic administration sends to the Central Meteorological Office a return of the disturbances produced by atmospheric electricity.

The Hydrological and Forest Departments also observe thunderstorms at about 900 stations.

Phenological observations are made at 1,500 stations, and the number increases every year.

Marine observations.

5°. The vessels of war, and a great number of merchant ships make simultaneous observations, corresponding to those of the United States Signal Office, viz., at 4h. 18m., 12h. 18m., and 8h. 18m. mean Paris time.

The observations made on board merchant ships are collected at the principal ports by a special staff, which also undertakes the comparison of instruments.

Weather telegraphy.

6°. The telegraphic weather service consists:—

(1.) Of the receipt of observations from international stations which form the basis for the construction of the charts of the International Bulletin. The observations are published in the same bulletin.

(2.) Of the transmission of forecasts to the ports.

(3.) Of the transmission of agricultural forecasts to communes which have subscribed for them.

(4.) Of the transmission of storm warnings to the Ministry of Marine.

The telegrams for the ports, the bulletin and the weather charts are drawn up by the branch for weather telegraphy.

The Central Office.

7°. The staff of the Central Meteorological Office consists of a director, three heads of service, and of adjuncts and assistants.

It has the assistance of a Council composed of delegates of various ministries, and of the Academy of Sciences. This council meets every three months.

The Director calls a meeting of the heads of service every month, at which scientific questions and matters relating to the progress of the service are discussed.

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The Central Meteorological Office is divided into three distinct branches :—

1°. Warnings to sea ports and for the benefit of agriculture. This branch draws up forecasts and the daily weather reports, and discusses the thunderstorm observations and the forecasts.

2°. Climatology. This branch is charged with the organisation and superintendence of the stations and observatories, undertakes the inspections and publishes the meteorological observations and various memoirs bearing more particularly upon climatology.

3°. General meteorology. This branch is charged with the organisation of observations at sea, at the Consulates, and in the French colonies, and studies more especially general meteorological questions.

The instruments used are too numerous to be described here ; those in general use are described in the Instructions of the Central Office.

8°. Only the observatories or stations of the First Order have a paid staff; the observers at other stations mostly belong to public services and observe gratuitously. At stations of the Third Order in certain cases some remuneration is granted by the Meteorological Commissions. The staff.

The staff of the Central Office consists of titular meteorologists with salaries varying from 120*l.* to 400*l.*; adjuncts, 100*l.* to 200*l.*; assistants, 48*l.* to 100*l.*

9°. The Central Office publishes every year the Annals of the Central Meteorological Office, in four volumes :— Publications.

Vol. I. *Etude des orages en France et Memoires divers*, including memoirs on the weather service, on thunderstorms, and on questions relating to weather forecasts, as well as papers by meteorologists, whether they belong or not to the office.

Vol. II. *Observations Françaises et Revue Climatologique.* This volume contains, as its name indicates :—

1°. The details of the observations from the observatories of the First Order and from a certain number of stations of the Second Order in France and Algeria, and a *resumé* of the observations of the stations of the First and Second Orders, a climatological review with charts, in which the principal characteristics of each month in the West of Europe are discussed.

Vol. III. *Pluies en France.* This volume contains the detailed observations of rainfall in France for a large number of stations, and a *resumé* of the observations for other stations which have not found a place in the detailed tables. A general *resumé*, with discussions of wet periods and charts of the distribution of rainfall, accompany the volume.

Vol. IV. *Météorologie générale.* This volume contains discussions on the distribution of the meteorological elements over the surface of the globe and memoirs upon general subjects. From the year 1882 it will also contain observations from the Consulates and from French colonies.

10°. The office is managed by the director, with the assistance of a responsible secretary. The stations are inspected either by the director, by the head of the climatological service, or by one of the staff, charged with a temporary mission. Management and inspections.

11°. The Central Office is in permanent relation with the Meteorological Commissions. The latter, which are nominated in each department by the Prefect, are composed of engineers, professors of sciences, and persons more particularly interested in meteorology. These Commissions organise the thunderstorm observations in the departments and direct in general all the meteorological work of their districts. Supplementary remarks.

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Their delegates attend a general meeting of the council of the Central Meteorological Office, which takes place once a year, for the purpose of examining the progress and the requirements of the Commissions. The Central Office supplies instruments to the Commissions.

The Commissions have funds provided either by the local administrations or by persons interested in the science. A large number of them publish bulletins of their operations.

Historical.

12°. The study of meteorology in France was first organised by Leverrier at the Paris Observatory. Some months after the death of Leverrier the decree of the 14th May 1878 constituted a distinct service for meteorology under the title of the Central Meteorological Office.

GERMAN EMPIRE. A.—BAVARIA.

Dr. v. Bezold, Royal Central Meteorological Station of Bavaria, Munich.

Definition of system.

1. The Royal Central Meteorological Office of Bavaria at Munich is entrusted with the duty of collecting meteorological observations in the kingdom of Bavaria; and it examines and prepares them for publication. Generally speaking it serves as a centre for all observations in the domain of meteorology, excepting forest meteorology.

Number and positions of stations.

2. At present there are 36 stations under the Central Office. These have been fitted out and are maintained at Government expense. They are called "normal stations." There are, however, in connexion with them, the Royal Observatory of Bogenhausen near Munich, as far as the meteorological and magnetical observations carried on there are concerned, and 10 other stations which are subordinate to the Central Office as regards the testing of their instruments, the supply of forms, &c., though not financially. These are called "supplementary" stations. The stations are classified as follows:—

(*a*) Two stations of the First Order. (1) The Royal Bogenhausen Observatory near Munich, lat. 48° 9′, long. 11° 34′, height above sea, 1,735 feet. (2) Kaiserslautern, lat. 49° 27′, long. 7° 46′, height above sea, 794 feet.

(*b*) Twenty stations of the Second Order, viz. 15 normal and 5 supplementary stations.

(*c*) 23 stations of the Third Order: 18 normal and five supplementary stations.

Organisation of stations.

3. Bogenhausen possesses the well-known self-registering instruments left by Lamont. Kaiserslautern has a self-registering anemometer of the same kind as that in use at the *Deutsche Seewarte*, a Hipp's thermograph and a barograph by the same maker, and in addition, the complete outfit of a station of the Second Order.

The stations of the Second Order have the following instruments.

1. Barometers, mostly station barometers with reduced scales, by R. Fuess of Berlin; a few have Fortin's barometers by Forster and Lenoir of Vienna.

2. Dry and wet bulb thermometers and minimum thermometers in a screen. Many of the stations have double louvres placed on the sides of the screen.

3. A couple of rain-gauges.

4. A Koppe's hair hygrometer.

5. A few stations have wind vanes or pennons.

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The stations of the Third Order have,

1. Maximum and minimum thermometers and check thermometers, mostly in double sets.

2. A couple of rain-gauges.

The hours of observation at the stations of the Second Order are 8 a.m., 2 a.m. and 8 p.m.; at the stations of the Third Order 8 a.m. and 8 p.m. Observations are made according to the "Instructions for observers at Meteorological Stations in the Kingdom of Bavaria," published by the Royal Bavarian Central Meteorological station at Munich (Munich 1878, T. Ackermann).

The tables used are found in those Instructions as well as in Volume I. of the "Observations in the Meteorological Stations of the Kingdom of Bavaria."

The registers received monthly from the stations are carefully checked between the 2nd and 10th of each month at the Central Office, both numerically and graphically. The stations are also inspected from time to time and the instruments verified there.

Special observations.

4. Apart from the observations of the regular meteorological stations, there is a great number of volunteer observers distributed over the whole country who send to the Central Station observations of thunderstorms, hail, and of special atmospheric phenomena. The total number of stations which sent communications of this nature amounted to 252 in the year 1882. These communications are written on cards provided for this purpose, and are sent in immediately after the observations. In the year 1882, 4,701 such cards were received, of which 4,162 contained reports of thunder, the rest reports of sheet-lightning only.

Weather telegraphy.

6. The Central Station receives telegrams from three of its own stations, and also from the *Deutsche Seewarte* and the Central Meteorological Office at Vienna. These telegrams contain reports from 50 stations embracing the whole of Europe, with the exception of the Pyrenean and Balkan peninsulas. Four telegrams are sent to the *Deutsche Seewarte*. The Central Office sends a collective telegram to Vienna, whence it is forwarded to Italy. Two weather reports are prepared from the telegrams received daily at the Central Office, a morning report, which contains only the observations from four Bavarian stations and a summary based principally upon the telegrams of the previous day, regard being paid to the inland telegrams received soon after 9 a.m. This morning report is inserted in two Munich papers. In the afternoon a weather chart is issued with the report and manifold copies are made. It contains together with the isobaric chart (printed in black on blue ground) the morning observations from 42 stations as well as a summary of the weather, as complete as can be made, and a forecast for the next day and for the different climatic districts of the kingdom. The forecasts are distributed by telegraph, according to a code of from one to three groups of letters. The groups have reference to the different climatic districts of the country. The first letter of each group refers to the wind, the second to the clouds, the third to rainfall, the fourth to temperature, and the fifth contains general remarks. These forecasts can be subscribed for at each Bavarian telegraph station. The subscription is 2*s*. a month, 8*s*. a quarter, and 15*s*. a half year. Each subscriber receives the key for converting the telegrams. The telegraphic administration undertakes entirely the distribution of these telegrams. The latter receives the noon report from the Central Office about 4h. p.m. The Weather Chart is issued about 5h. p.m.

The Central Office.

7. The Central Office is directly under the ministry for Church and School affairs. It is at Munich, but has no special building. Its

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outfit, therefore, scarcely corresponds to a station of the First Order, and its observations are only published as those of a station of the Second Order.

The staff.

8. The staff of the Central Office consists of a Director, who carries on that duty at the same time as his work as a Professor.

	£
His salary is - - -	150
One adjunct (salary) - - -	150
One assistant „ - - -	75
Two „ (each) - - -	60

and a man servant.

The accounts are managed by the accountant of the Royal Academy of Sciences. The observers of the regular stations (the normal stations) receive remuneration as follows:

	£ s. £
Stations of the Second Order - -	12 10 to 15
Stations of the Third Order - -	6

The total cost of the meteorological service in Bavaria is, so far as the public funds are concerned, 782*l.* for salaries, &c., and 388*l.* for expenses; total 1,170*l.* a year.

There is an addition from an agricultural fund of 180*l.* for the weather forecasts.

Publications.

9. The Central Office publishes the daily observations of all the normal stations as well as monthly and yearly summaries in a work entitled, *Beobachtungen der meteorologischen Stationen im Königreich Bayern, herausgegeben von den Centralstation durch Wilhelm von Bezold und Carl Lang.*

The work appears quarterly and contains, besides the above-mentioned observations of all the normal stations, those on thunderstorms in Bavaria and Württemberg (the observations of these phenomena in Württemberg are sent monthly for discussion from the Central Office at Stuttgart) as well as older observations made in Bavaria. The fourth volume of this work is now in the press. The Central Office also publishes monthly the "*Übersicht über die Witterungsverhältnisse in Bayern,*" for the preceding month.

These monthly summaries appear first in a newspaper (the *Augsburger Abendzeitung*) and are then separately printed for distribution by the Central Office. The "Weather Charts and Weather Reports" which are issued daily have been already mentioned.

Management and inspections.

10. The Central Office undertakes the management and inspection of the stations.

Historical.

12. The meteorological service in Bavaria was established in 1878. The Central Office began work on the 1st October 1878. The stations, after three months' practice, began regular observations on the 1st January 1879. Some of them had been previously established at the cost of local authorities, &c., or by private persons, and had already been working for some years. These were simply incorporated in the system but their outfit was completed.

The Central Office issued telegraphic weather reports in the course of the first year, and actual weather forecasts were begun on 1st April 1881.

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GERMAN EMPIRE. B.—HAMBURG.

Dr. G. Neumayer, Deutsche Seewarte, Hamburg.

Introduction.

The meteorological service in the German empire is carried out by different systems, which are connected with each other and which are limited by the political divisions. The organization of the *Deutsche Seewarte* is the only one which is imperial, and it is the central office for maritime meteorology and for weather telegraphy. In this respect the domain of the *Seewarte* extends over the whole empire.

The other systems, which, although independent of it, yet work in harmony with it and each other, are:

1°. The meteorological system for the Kingdom of Prussia, and the smaller states, which are connected with it as regards their meteorological work.

2°. The meteorological system for the Kingdom of Bavaria.
3°. „ „ „ Saxony.
4°. „ „ „ Württemberg.
5°. „ „ Grand Duchy of Baden.
6°. „ „ Imperial Provinces of Alsace-Lorraine.

Presuming that the directors of the separate systems have replied to the circular of the International Meteorological Committee respecting meteorological organizations, which has been ascertained by a circular issued by the member of the committee for Germany, this paper will only refer to the organization of the *Deutsche Seewarte* and of the branches connected with it. The meteorological organization of the Grand Duchy of Baden and of the Imperial Provinces will only be touched upon in a general way, as special reports of these have not been sent in.

It must here be remarked that the directors of the different central meteorological offices in Germany are accustomed to hold conferences on all questions of importance, the decisions of which are binding on the separate systems and are accepted as regulations in the organizations of the separate countries.

The system of the Deutsche Seewarte at Hamburg.

Definition of system.

1. As is seen from the Introduction, the system of the *Seewarte* with respect to maritime meteorology embraces the whole German empire. With regard to weather telegraphy we must make a distinction between storm warnings and inland weather forecasts. The first are entirely under the control and management of the Seewarte, and extend to the whole of the coast, from the Russian frontier in the east to the Dutch frontier in the west. The latter, the weather service, is, on the contrary, carried on by the systems of the different States for themselves, but in dependence on the Institute of the Seewarte. It consists in the first place of the receipt of the greater part of the foreign observations employed in the weather service, which are partly in their original form and partly as results, in the shape of synoptic charts and forecasts.

2. The system of the *Deutsche Seewarte* comprises nine normal stations, which may be considered as stations of the First Order.

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Number and positions of stations.

The following are the names and geographical positions of these stations:—

1. Hamburg,	lat. 53° 33′ N.,	long.	9° 58′ E.,	altitude	66	feet.
2. Memel,	„ 55° 43′ N.,	„	21° 7′ E.,	„	13	„
3. Neufahrwasser,	„ 54° 24′ N.,	„	18° 40′ E.,	„	13	„
4. Swinemünde,	„ 53° 36′ N.,	„	14° 17′ E.,	„	20	„
5. Wustrow,	„ 54° 21′ N.,	„	12° 24′ E.,	„	23	„
6. Kiel,	„ 54° 20′ N.,	„	10° 9′ E.,	„	154	„
7. Keitum,	„ 54° 54′ N.,	„	8° 22′ E.,	„	30	„
8. Wilhelmshafen,	„ 53° 32′ N.,	„	8° 9′ E.,	„	36	„
9. Borkum	„ 53° 35′ N.	„	6° 40′ E.,	„	13	„

Here some stations of the First Order may be named which belong neither to the above-mentioned meteorological systems nor to the *Seewarte*. They are independent, but send contributions to the reports of the *Seewarte*.

These stations are:—

1°. Magdeburg, lat. 52° 9′ N., long. 11° 37′ E., altitude 177 feet.

This station has been established by the proprietors of the "*Magdeburger Zeitung*," and is called the *Wetterwarte der magdeburger Zeitung*, and is maintained by the same.

2°. Frankfort o/M., lat. 50° 8′ N., long. 8° 41′ E., altitude 338 feet.

This station has been established by the Physical Society of Frankfort, and is maintained as its station.

3. Kaiserslautern, lat. 49° 27′ N., long. 7° 45′ E., altitude 794 feet.

This station was established by the funds of the Palatinate, and is maintained by it in the Royal Polytechnic School.

The system of the *Seewarte* has, in addition to the above-mentioned stations, which take the same observations as stations of the First Order, two supplementary stations, with an outfit like stations of the Second Order, and which also take similar observations, viz., Cuxhaven and Rügenwaldermünde on the Pomeranian coast.

It must here be mentioned that the Seewarte receives observations from stations of the Second Order, partly for the purposes of weather telegraphy, partly for publication according to the international scheme, as may be necessary. The details about these stations are to be found in the reports of the respective systems.

With regard to the number of stations of the Second Order, it is to be remarked that the Coast Signal Stations, 45 in number, are fitted out as stations of the Third Order, and should therefore be counted as stations of this kind belonging to the different systems in the districts in which they lie. If therefore an idea is to be formed of the number, proximity, &c. of the stations of the Third Order, the reports of the *Seewarte* and those of the different systems must be consulted.

Organization of stations.

3. The outfit of the stations of the First Order belonging to the *Seewarte* the (normal observing stations) may be seen from the details given in the First Annual Report upon the organization and operations of the *Deutsche Seewarte* in "*Aus dem Archiv der Deutschen Seewarte*," first year, 1878, pp. 33–4, as well as from No. 2 of the same work, "*Instruktion für den meteorologischen Dienst der Deutschen Seewarte*," pp. 5–16.

Respecting the hours and methods of observation, as well as the keeping of the meteorological registers at the stations of the *Seewarte*, the necessary information will be found in the same work, "*Instruktion*, &c." pp. 17–23, and in the instructions for signal stations, pp. 18–20. No change has been made since the publication of that information.

For the reduction of the observations the tables compiled by the

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Seewarte are used; for the reduction to sea-level those published by Dr. C. Jelinek are generally used.

The observations are constantly checked at the *Seewarte*. Department III. of this institution has a special employé, whose duty it is to check and collate the observations, and this officer inspects the stations. The method of examination is in its details different for the stations of different orders, according to the matter to be dealt with, but it is essentially the method generally adopted, and therefore it is unnecessary to go into further explanations.

Special observations.

4. With respect to this question it is to be observed that the system of the *Deutsche Seewarte*, as already mentioned, has to deal specially with storm warnings, and that climatological researches scarcely form one of its objects, as these are attended to by the different systems of meteorological investigation in Germany. Therefore we can only repeat here, what has been already said about stations of the Second Order; the work of the *Deutsche Seewarte* with respect to climatological research in Germany can only be regarded as supplementing the arrangements of the separate systems.

Observations of thunderstorms and hail are made at all the signal stations on the coast, and they report these phenomena immediately after their occurrence to the Central Office at Hamburg by means of specially prepared cards (as in Bavaria and Württemberg). It will be seen from what has been said that phenological observations do not form part of the working plan of the *Seewarte*. These are occasionally made by private persons in Hamburg and other places, and sent to the *Seewarte*.

Marine observations.

5. The organization of maritime meteorological observations, in strict accordance with the decisions of the International Meteorological Conference held in London in 1874, has been carried out since 1876 in considerable detail.

The yearly reports of the *Deutsche Seewarte*, from 1875–1878, 1879, and 1880, give all the necessary information as to the arrangements and the different points determined upon, as well as about the historical development of maritime meteorology in Germany. These yearly reports are contained in "*Aus dem Archiv der Deutschen Seewarte*," in Nos. 1, 3, and 1 of the yearly vols. I., II., and III.

The following is a brief sketch of the condition of maritime meteorology at the *Deutsche Seewarte* at the end of the year 1882. Agencies have been established along the coast, on the one hand, to awaken interest for meteorological work in the ports of the German coast, and on the other to simplify the distribution and examination of registers and instruments, and to spread as far as possible the benefits which navigation may derive from this investigation. These agencies are divided into principal agencies, which are provided with everything necessary for testing instruments (and especially the determination of Deviation on board iron ships). These principal agencies are at Bremerhaven, Swinemünde, and Neufahrwasser. The outfit and organisation of these principal agencies, as well as the agencies to be mentioned directly, may be learnt from the above-mentioned yearly reports. The *Deutsche Seewarte* has 11 agencies on the coast, in addition to those already mentioned.

In order to further this part of the efforts of the *Deutsche Seewarte* abroad, the German General Consulates and Consulates are provided with registers, which are issued to captains at their request, and they co-operate with the institution by returning the registers above mentioned, by distributing publications to seamen, &c.

Captains, at their request, are supplied with sailing directions prepared

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for certain routes, special attention being paid to modern views of meteorology and less to mere statistics. The number of sailing directions issued gradually decreases in proportion as the number of publications of the institution increases. The issue of a work, "The Pilot," a guide for sailing ships, has been especially beneficial in this respect; two volumes of this work have already appeared, and the third is in the press. Also the various articles on maritime meteorology and ocean tracks in the "*Annalen der Hydrographie und maritimen Meteorologie*" may be mentioned here. A sailing Handbook for the Atlantic Ocean is also in the press.

In order to form an idea of the extent of the materials available, the following figures will be useful:—

In 1882, the first section of the *Seewarte*, received complete meteorological registers from 221 sailing ships and 79 steamships, altogether 300 in number, in addition to 43 from ships of war.

206 extracts from logs were received and were used chiefly for the synoptic work of the North Atlantic Ocean. These contain observations made at 8 a.m. and 8 p.m. (but only from ships supplied with mercurial barometers), while the complete logs contain observations six times a day, at the hours agreed upon at the International Conference.

The contents of all the logs received in the year 1882 may be gathered from the following round numbers:—

The 300 complete logs of the Mercantile Marine contained 1355 months = 247,890 sets of observations.

The 43 complete logs of the Navy contained 189 months=34,670 sets of observations.

The 206 extracts of the Mercantile Marine contained 178 months= 10,880 sets of observations.

Altogether, therefore, the maritime observations collected by the first section of the *Seewarte* in 1880 amounted to 1,722 months=293,440 sets of observations.

It must be remarked that this extensive material is spread over all the commercial routes of the ocean, and that it is of the first quality. Ordinary logs containing observations made, not with the instruments of the *Seewarte*, but with instruments tested at the *Seewarte*, are excluded from the collection and discussion.

The material is used in three different ways:—

1. Extracts are made of meteorological observations, and matters interesting to navigation are extracted from the ships' logs of all voyages, and are at once published in the *Annalen der Hydrographie und maritimen Meteorologie.*

2. The results of the observations combined with those made on board Dutch ships are arranged in climatological and general meteorological tables and published in one-degree squares for each month.

3. The *Deutsche Seewarte* constructs synoptic charts for the N. Atlantic Ocean and for each day of the year from the ships' observations. There are, on an average, from 50 to 55 observations for 8 a.m. for different positions available.

A strict check on the observations is carried out by means of this synoptic work.

The Danish Meteorological Institute and the *Deutsche Seewarte*, by means of this material and that obtained from Danish ships, have issued daily synoptic charts since December 1880.

It need scarcely be mentioned that the whole of the observations obtained from seamen are made without pay. They receive in return the publications of the *Seewarte*, and have for a number of years received other large works, which are important for them.

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On the day of the inauguration of the new building of the *Seewarte* a medal was struck, which is presented to the co-operators with the *Seewarte* at sea, in three grades, together with a suitable diploma. The first grade is gold, the second silver, and the third bronze.

Weather telegraphy.

6. The *Deutsche Seewarte* acts as the Central Office for weather telegraphy for the empire, and especially for the storm warning system of the German coasts.

The organisation of the whole service may be learned from the publications. The following is a list of these publications :—

1. First Yearly Report on the Organisation and Operations of the *Deutsche Seewarte*, section ix., pp. 110–27.
2. Second Do., 1879, section ix., pp. 66–74.
3. Third Do., 1880, section ix., pp. 78–92.
4. Instructions for Signal Stations of the *Deutsche Seewarte*, second edition.

It may be remarked that since 1880 the service for weather telegraphy for the German Empire has not been much extended, chiefly owing to the fact that for Prussia and the Imperial domains (Alsace Lorraine) no special offices have yet been established which could be connected with the operations in this direction.

The reports of the Central Offices of the different countries will show the condition of weather telegraphy and forecasts in the respective countries.

It is also worthy of remark that from the 1st November 1882, a limited evening service was established at the Seewarte, in the interest of storm warnings. The observations for 8h p.m. (and for England, 6h p.m.) are collected, discussed, and, if necessary, storm warnings are issued. These arrangements have been maintained, but have stopped for the summer months, and will be resumed at the commencement of the stormy season.

The Central Office.

7. The Central Office consists of four departments, and in addition there is a course of instruction for intending teachers at navigation schools, exclusive of the administration branch.

The first department has charge of maritime meteorology, the second of the verification of instruments, the third of the storm signal service, and the duties pertaining to the Central Office of weather telegraphy for the German Empire.

The organisation of the Central Office at Hamburg is, so far as regards meteorology, a station of the First Order, with two, and in special cases three, sets of self-recording instruments.

For the comparison of instruments, the most tried and complete arrangements are made.

For barometers, a standard barometer with a differential cathetometer.

For thermometers, an apparatus on Fuess's principle.

For anemometers, a Combe's apparatus of 4 metres radius, and for velocity, between 1 metre and 26 to 30 metres a second, on Neumayer's principle.

From these data the arrangements for all other comparisons may be inferred.

Descriptions of the arrangements at the Central Office may be found in :—

(1.) First Yearly Report on Organisation, &c., 1875–1878, section iii. pp. 14–29.

(2.) Second Yearly Report on the Work, &c., 1879, section iii., pp. 5–7.

(3.) Third Yearly Report on the Work, 1880, &c., section iii., pp. 8–22.

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In the year 1881 the *Deutsche Seewarte* was removed to the large buildings erected specially for the purposes of the Institute on the Stintfang, at Hamburg.

The arrangement of this building, as well as the structure itself, will be described in a special publication with illustrations, a reference to which can only be made here.

With regard to the arrangements of the subordinate stations of the *Seewarte*, we must refer to what has been said elsewhere in this report about the normal stations, the supplementary stations, the principal agencies, agencies, and signal stations. We must also refer to the frequently mentioned publications of the *Seewarte*.

The staff.

8. The whole system of the *Deutsche Seewarte* is under the management of a Director, who receives a salary of 525*l.*, and free apartments, provided by the State.

The First Department, for maritime meteorology, is under a head of a department, who receives an average salary of 240*l.*, with an allowance for residence.

In the First Department, three assistants are engaged, with an average salary of 135*l.*

The Second Department, for the verification for all kinds of instruments, including those necessary for meteorological purposes, is under the management of a head of a department, with an average salary of 240*l.*, and an allowance for residence.

There are two assistants in this department, with an average salary of 135*l.*

The Third Department, for meteorology and storm warnings, is under a head of a department, with an average salary of 240*l.*, with free apartments. There are five assistants engaged in this department, including an inspector of stations, with an average salary of 135*l.*

There is also a scientific assistant appointed as meteorologist to the Institute, but he is not specially attached to any of the departments. He undertakes the discussion of general scientific questions of a meteorological character, has the standing of head of a department, and receives an average salary as such.

There are also engaged in the Institute in the interest of meteorology:—

One telegraphist, with a salary of	- £105
One draughtsman - -	- 100

The officials in the Administrative Department are employed for the whole Institute in all branches, and will therefore not be referred to here.

The superintendents of the principal agencies, two of which are also superintendents of stations, receive 120*l.*

The superintendents of the normal stations receive 22*l.* 5*s.* on an average.

The superintendents of agencies receive 6*l.* on an average; the superintendents of the signal stations receive 7*l.* 10*s.* a year.

The superintendents of supplementary stations (of Second Order) receive 7*l.* 10*s.*

Wherever it is practicable, the signal stations are either attached to normal stations or to the agencies, in which case the officials receive the accumulated pay.

Publications.

9°. The publications of the "*Deutsche Seewarte*" are stated in detail

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in the annual reports, which have already been frequently quoted, and may be referred to here :—

I. Yearly Report, 1875–8, section xi., pp. 134–142.
II. „ 1879, „ xii., pp. 80–3.
III. „ 1880, „ xii., pp. 96–9.

Of large works, the following have appeared up to the year 1882 :—

(1.) Two volumes of "The Pilot," a guide for sailing vessels.
(2.) An Atlas of the Atlantic Ocean, which belongs to the sailing handbook, which will appear shortly.
(3.) Tables of meteorological observations, made on German and on Dutch vessels in four ten-degree squares in the N. Atlantic. Squares 146, 147, 110, 111.
(4.) The "*Monatliche Übersicht der Witterung*," 1876–82 (seven years).
(5.) The Daily Weather Reports and Charts, 1876–82 (seven years).
(6.) The Meteorological Observations on the International Scheme for 17 stations of the Second Order, 1878–80 (three years), with Hourly Observations of the Normal Stations of the *Deutsche Seewarte*.

No separate publications are issued by the stations.

Management and inspection.

10°. The management of the system, so far as this is not of a technical nature, is carried out under the superintendence of the Director by its own administrative officials.

The collection of models and instruments at the Central Office and the large library, comprising nearly 16,000 volumes, and for which a librarian is specially appointed, require special care in their management.

A special officer is appointed for the inspection of the stations ; he visits the stations and compares the instruments, &c.

The Director also visits all the stations in addition to the Inspector (say every two years), and the heads of the departments interested also inspect the stations referring to their respective departments. Generally speaking, each of the stations is inspected at least once a year, and the arrangements, books, &c. are subjected to a thorough revision.

Supplementary remarks. Historical.

11. No special remarks can be added to those already detailed above.

12. The system of the *Deutsche Seewarte*, as it at present exists, was established in January 1875, and was amalgamated with the system founded by the *Norddeutsche Seewarte* in the year 1867 for the work of maritime meteorology and meteorological observations at Hamburg.

The development of this system of the *Deutsche Seewarte* will be most plainly seen from the following publications :—

I. Yearly Report, 1875–8. Section II., pp. 4–9, Section VII., pp. 60–3, and Section IX., pp. 110–113.
II. Yearly Report, 1879, Section II., pp. 3–5.
III. Yearly Report, 1880, Section II., pp. 4–6.

The most important event in the history of the *Deutsche Seewarte* is the construction of the Central Office, the fitting up of the rooms and the installation of the instruments, which was nearly completed at the end of the year 1882, after the building had been inaugurated and occupied on the 14th September 1881.

The Grand Duchy of Baden, Central Office, Carlsruhe.

Sixteen stations of the Second Order. No stations of the First or Third Orders exist. The highest station, Höhenschwand, altitude 3,322 feet. The observations are made at 7h. a.m., 2h. and 9h. p.m. Baden does not take part (like Württemberg) in the Bavarian thunder-

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storm service. The weather forecast service was introduced in May 1882, and is restricted to the warm season of the year. The forecasts were checked in June 1882 at 28 stations, and gave an average success of 82·6 %.

Publications.—A yearly report, containing—

1. Temperature, 5-day means from observations at $\frac{7+2+2+9}{4}$; monthly means from observations at 7h. a.m., 2h. and 9h. p.m., true monthly means, and yearly means.
   Extremes of temperature, for summer and winter days.
2. Atmospheric humidity. Monthly and yearly means at 7h. a.m., 2h. and 9h. p.m., for vapour tension and relative humidity.
3. Rainfall, &c., monthly and yearly amounts. Maximum in month and year. Number of days on which rain fell.
4. Amount of cloud (0—10) at 7h., 2h., and 9h., and mean for month and year. Number of clear and overcast days.
5. Thunderstorms; distribution according to time and place. Number of days on which thunderstorms occurred, with month and year.
6. Air-pressure, daily means for Carlsruhe and Höhenschwand, monthly means 7h. a.m., 2h. and 9h. p.m., month and year.
   Extremes of air-pressure, month and year.
7. Wind, number and force (0—4) of the different winds (16 points). Month and year.
8. Height of water of Lake Constance at Ueberlingen (for each day). Month, year, and extremes.
9. Summary of the weather in the different months.
10. Means and extremes of the lustra.

The Imperial Domains of Alsace-Lorraine.

After the interruption of the meteorological observations by the Franco-German war, several stations of the Second Order were established in the years 1875–7 by the Statistical Bureau of the Administration. Of the observations for the year 1877 only those of Strassburg have been published (*in extenso*). In the publications of the years 1878–81, however, the individual values as well as the monthly and yearly means of 9 or 10 stations have been published; the altitudes vary from 407 to 1,637 feet.

The management of the meteorological system is, up to the present, wanting in uniformity. In order to meet this defect and to prepare for the establishment of a central meteorological office and a station of the First Order, which shall at the same time undertake the service of weather telegraphy, Dr. Sprung, Assistant at the *Deutsche Seewarte*, was sent to Strassburg in the summer of 1882. The funds for carrying out the new organisation cannot be provided before the financial year 1884–5.

It should also be mentioned that in the year 1876 three very good working pairs of forest meteorological stations were established by the Ministry of the Imperial Domains, and in the course of the years 1873–9 about twenty Rain stations were also established by the Administration of Waterworks and Drainage. An independent monthly publication of the observations of the forest stations has existed since 1882. A meteorological service in the interest of agriculture and forestry has not yet been organised, but is to be established next year.

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GERMAN EMPIRE C.—PRUSSIA.

Dr. G. Hellmann, Royal Meteorological Institute of Prussia, Berlin.

Definition of system.

1. The Royal Prussian Meteorological Institute, was founded in the year 1847 as an independent department of the Royal Prussian Statistical Office, in which it is located and with which it is administratively connected.

Number and positions of stations.

2. The stations of the Institute embrace the non-Prussian stations in Mecklenburg, Oldenburg, Brunswick, and the small Saxon States (Saxe-Coburg, &c. &c.) which send their observations either direct or through some local authority.

There is no actual station of the First Order, but at Schwerin two-hourly observations of air temperature and wind direction have been made since 1853 and published *in extenso* since 1880 (and formerly in abstract).

The number of stations of the Second Order amounts to 133, including the 16 forest-meteorological stations, for which the Central Office is Eberswalde. There are 24 stations of the Third Order. The four high-level stations—Schneekoppe (5,249 feet), Schneegrubenbaude (4,889 feet), Glatzer Schneeberg (3,970 feet), Brocken (3,747 feet)—are worthy of special mention.

Organisation of stations.

3. The stations of the Second Order have barometers (siphon-barometers, compensated cistern barometers or cistern-siphon barometers), August's dry and wet bulb thermometers (two thermometers graduated to $\frac{1}{5}°$), and some have also Hair-hygrometers by Höttinger and Co., of Zürich, also maximum and minimum thermometers, rain and snow gauges (the old ones with square receivers of 1 Paris sq. foot in area, the recent ones with circular receivers having an aperture of $\frac{1}{200}$ sq. metre) and wind-vanes.

The exposure of the thermometers is mostly in front of windows; metal thermometer screens on Wild's principle were erected in the year 1882 at two stations only, and at the same time ventilators were fitted to the hygrometers.

The stations of the Third Order are supplied with maximum and minimum thermometers, with check thermometers graduated to half degrees and with rain and snow gauges.

The hours of observation at most of the stations of the Second Order are 6 a.m., 2 and 10 p.m.; or else the combinations 7, 2, 9; 8, 2, 8; 8, 2, 10, are taken.

Up to the year 1879, the Instructions in force in 1847 were used, with unimportant alterations. They were then replaced by new ones, in accordance with the international regulations.

The tables of reduction in use are Jelinek's Humidity Tables (formerly those of Suhle for Réaumur degrees), and small tables on yellow cards for the reduction of the barometer.

By far the majority of the observers, who mostly belong to the educated class, reduce their own observations, so that only a few of the observations require recalculation or thorough checking. The calculations of the trustworthy observers are always subjected to a slight examination.

Weather telegraphy.

6. There is no special telegraphic weather service; some inland stations send their 8h. a.m. and 2h. p.m. observations by telegraph to the *Deutsche Seewarte* at Hamburg.

The Central Office.

7. The Central Office possesses no central observatory, but is only a central place which collects the observations of the stations, checks, dis-

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cusses, and publishes them, verifies the instruments, inspects the stations &c. The administration (office business, registration, accounts) is carried on by the staff of the Royal Statistical Office.

The institute uses as standard barometers a cistern-siphon barometer by Fuess and a siphon barometer by T. C. Greiner, senr. The standard thermometers are from Kew and Greiner.

The staff.

8. The scientific staff is composed of a director and an assistant. See No. 7. The first receives (in the branch office), 210*l.*; and the latter 135*l.*, with an addition for apartments.

About 70 of the observers receive remuneration, those at stations of the Second Order on an average 11*l.* 5*s.*, the maximum amount being 15*l.*, those at stations of the Third Order from 2*l.* 10*s.* to 5*l.* The total amount of the remuneration paid to observers is 825*l.*

Publications.

9. The publications of the Meteorological Institute are specified in the accompanying sheet (*Preussische Statistik*).

Management and inspections.

10. From four to five weeks are taken up yearly in the tours of inspection of the stations, so that all the stations are visited once every four years.

Historical.

12. The Institute was founded in the year 1847 at the instigation of A. von Humboldt. Its directors have been A. W. Mahlmann until 1848; H. W. Dove until 1879; T. A. Arnot till 1881, and subsequently the undersigned.

For many years it has been intended to reorganise the institute completely; but owing to the difficulty in obtaining the necessary funds, which are considerable, the carrying out of the plan already prepared has not been undertaken.

GERMAN EMPIRE. D.—SAXONY.

Dr. Paul Schreiber, Chemnitz.

In returning my best thanks to you for your congratulations upon my undertaking the superintendence of the Meteorological Institute and for your contributions to our library, I have to beg that you will excuse me for not replying to the circular of the International Meteorological Committee, dated 31st December 1882. This omission has been intentional, because such important changes have taken place, and are still taking place, in my Institute, that any replies relating to 1882 would not only be worthless, but would rather do harm by the dissemination of particulars about arrangements which are now abandoned.

During the lifetime of M. Bruhns the meteorological work was pursued *con amore*, as an addition to the regular work of the Astronomical Observatory.

I have changed all this, and have now a considerable office, provided with the necessary staff (at present 9 officials) and I am endeavouring in every respect to get the Meteorological Institute taken up as a permanent establishment of the State by the time of the next session of the Diet of Saxony.

You will understand that I am desirous that no publication of our organisation should be made until after the attainment of more or less permanent arrangements.

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GERMAN EMPIRE. E.—WÜRTTEMBERG.

Dr. Schoder.—Royal Central Meteorological Station of Württemberg, Stuttgart.

Number and positions of stations.

2. The Meteorological System of Württemberg consists, at present, of 24 regular stations, at which pressure, temperature, wind, cloud, rainfall, vapour tension, and humidity are observed, and of three stations which simply observe rainfall. There are also about 50 additional observers, who send in phenological notices, as well as observations of thunderstorms and hail. All these observations are collected and discussed at the Central Meteorological Station at Stuttgart (lat. 48° 47′ N., long. 36° 43′ E. of Greenwich; height above sea, 833 feet). The height above sea of the regular stations varies from 545 to 2,635 feet.

Organisation of stations.

3. The regular stations are supplied with the following instruments:

(1.) Barometer: Some stations have had since 1874 cistern barometers, made by Hermann and Pfister of Berne. The cistern is generally sufficiently large to obviate the application of a correction for capacity. At the other stations siphon barometers are used.

(2.) Thermometers: Since 1872 these are all graduated in Centigrade degrees, at some stations to $\frac{1}{2}°$, at most stations to $\frac{1}{5}°$. The minimum thermometers are spirit thermometers. The thermometers are exposed in louvred screens. In addition to the dry and wet bulb thermometers, hair hygrometers are supplied to some stations, which have been lately procured from Höttinger and Co. of Zürich. The latter serve on the one hand as a check on the dry and wet bulb thermometers, and on the other occasionally replace them (*e.g.*, in winter).

(3.) Raingauges: These have mostly square receivers of one Paris foot square; for measuring, a glass tube, graduated in Paris cubic inches, is used. At the more recent stations circular gauges, like the gauges used in Switzerland, have been set up lately.

(4.) Wind vanes: These are used only in Stuttgart and a few other stations. These have a Wild's wind-pressure plate; elsewhere the wind-force is estimated.

The hours of observation are 7h. a.m., 2h., and 9h. p.m.; for rain, 7h a.m.

The reduction tables employed for the thermometer correspond with those published by Jelinek. For vapour-tension and humidity, Jelinek's tables are supplied to the observers.

Special observations.

4. Special notices about thunderstorms and hail have been received since 1874 from extra observers; since 1880 this service has been facilitated by postcards, previously printed. The method is the same as in Bavaria. The number of cards received in 1882 amounted to 787 from 52 observers.

Weather telegraphy.

6. Since the 1st April 1881, forecasts have been drawn up at the Central Office, based upon two telegrams from the *Deutsche Seewarte*, and one telegram from the Central Office in Zürich. At the same time the weather chart is printed by the hectograph process and distributed. In summer, forecasts are issued by telegraph to the country stations. A summary of the success is given in the *Monatliche Übersichten der Witterung* published by the *Deutsche Seewarte*.

The Central Office and staff.

7. and 8. The Central Office, to whose duties belong the taking of daily observations of the weather, has the undersigned as Director, and as meteorological assistant, the engineer L. Meyer, of Stuttgart. The latter is entrusted with the special duty of drawing up the forecasts and of drawing the Weather Charts. In addition to the above-mentioned instruments, the Central Office possesses a registering aneroid-barometer

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by Goldschmid, of Zürich, a registering thermometer and wind-gauges by Hermann and Pfister of Berne and by Goldschmid.

	£	s.
The Director draws a salary of - -	90	
The assistant „ „ - -	91	5

and the observers receive remunerations of between 3*l.* and 10*l.* The special observers received 20*l.* altogether in 1882.

Publications.

9. The Central Office publishes:

(1.) The Daily Weather Reports of Stuttgart in the newspapers, "*Staatsanzeiger für Württemberg*," and "*Schwäbischer Merkur*."

(2.) The Stuttgart observations in the medical *Correspondenzblatt*.

(3.) The monthly results of the observations of all stations in the "*Staatsanzeiger für Württemberg*."

(4.) A weather report containing the results of observations of the stations in the Württemberg Year-books for Statistics and Agriculture.

Of the publications (2) to (4) are printed separately and sent abroad.

Management and inspections.

10. The financial management is undertaken by the Statistical and Topographical Office, to which the meteorological stations are subordinate, and of which the Director of the Central Meteorological Office is a permanent officer. The Director inspects the stations, the more important stations being visited every year.

Historical.

12. Since 1825 there has been in existence an Association of volunteer observers; these use their own instruments and observe on a uniform plan laid down by Professor Schübler and M. von Plieninger. The results were published in the "*Correspondenzblatt*" of the Agricultural Society of Württemberg. In 1844 the Association of Observers joined the newly founded Society for Natural Science; the publication of the results was made in the annual reports of the same until 1854. In 1855 the development of the meteorological statistics of the country was fixed as one of the duties of the Statistical and Topographical Office, and a sum of money was provided for the purchase of instruments, for remuneration, &c. It became possible thereby to establish more stations at points not hitherto represented, to supply the stations with uniform and compared instruments, and in the event of an observer leaving, it was easier, by offering remuneration, to find a successor, and to secure the continuance of the station.

Weather Reports have been issued since 1855 by the above-mentioned office, and since 1864 in special publications by Plieninger, who in 1867 published a resumé of 40 years results, viz., 1825–64.

In the year 1865 the present Director undertook the management of the stations and also the publication of the yearly reports in the Württemberg Year-books. In 1872 the centigrade thermometer was adopted and the graduation of the barometer in millimetres. From this cause and other minor changes which have taken place since the communication of the monthly results of a number of stations to the Royal Statistical Bureau of Prussia, drawn up by Plieninger, two supplements were issued ,to the Instructions in 1873. A third supplement became necessary, in order to conform to the decisions of the Meteorological Congress at Vienna.

Until 1864 it had been the practice of the observers to send in their observations for each year at the beginning of the next, which caused many difficulties in the checking. From 1865, therefore, the registers were collected monthly, by which means it became possible to publish a monthly summary of the weather in the "Staatsanzeiger."

In 1874, in accordance with the decisions of the Vienna Congress, the Central Station at Stuttgart was established, the director of which, Dr.

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Schoder, undertook the daily weather observations. In addition to the 24 regular meteorological stations, which were partially provided with better instruments, a large number of special observers were appointed in 1874, who have to send reports to the Central Station respecting hail, thunderstorms, and the animal and vegetable kingdom. Since 1878 some rainfall stations have been added. From 1874 the Central Station has received daily telegrams, originally sent from Berlin, and from the beginning of 1876 by the *Seewarte* at Hamburg. These, with the addition of reports from Friederichshafen and Stuttgart, were communicated to the "Staatsanzeiger." Württemberg is represented by Friedrichshafen, in the system of stations of the *Deutsche Seewarte*, and by Stuttgart and Friedrichshafen in the system of simultaneous observations originated at Washington by General Myer. The same two stations appear also in the German publications:—*Meteorologische Beobachtungen in Deutschland.* In the summer of 1880, thunderstorm cards were first introduced on the Bavarian plan, according to which the regular and special observers communicate the occurrence of thunderstorms on a form printed on a postcard. On the 1st April 1881, the central station at Stuttgart commenced the issue of weather forecasts, and on the 1st June following distributed the same by telegraph.

GREAT BRITAIN AND IRELAND.

A.—*R. H. Scott, Meteorological Office, London.*

1°. The Meteorological Office is managed by a Council, nominated by the President and Council of the Royal Society, at the request of the Government. Definition of system

The meetings of the Meteorological Council are held once a fortnight, or oftener when necessary.

The operations of the Office comprise the three following divisions:—

I. *Ocean Meteorology.*

II. *Weather Telegraphy and Signals.*

III. *Land Meteorology of the British Islands.*

2°. There are seven stations of the First Order, under the control of the Central Office (see also reply to 11°):— Number and position of stations.

Valencia,	lat.	51°	55′	N.,	long.	10°	18′	W., altitude 23 feet.
Armagh,	„	54°	21′	N.,	„	6°	39′	W., „ 207 „
Glasgow,	„	55°	53′	N.,	„	4°	18′	W., „ 184 „
Aberdeen,	„	57°	10′	N.,	„	2°	6′	W., „ 88 „
Falmouth,	„	50°	9′	N.,	„	5°	4′	W., „ 211 „
Stonyhurst,	„	53°	51′	N.,	„	2°	28′	W., „ 361 „
Kew,	„	51°	28′	N.,	„	0°	19′	W. „ 34 „

Self-recording anemometers have also been erected at the following stations:—

Alnwick Castle,	lat.	55°	25′	N.,	long.	1°	43 'W.
Holyhead,	„	53°	22′	N.,	„	4°	37′ W.
Sandwick,	„	59°	2′	N.,	„	3°	18′ W
Seaham,	„	54°	50′	N.,	„	1°	19′ W
Scilly,	„	49°	56′	N.,	„	6°	18′ W.
Yarmouth	„	52°	37′	N.,	„	1°	43′ E.

There are 43 stations of the Second Order (including some stations of the Meteorological Society, which supply observations to the Central Office), and 18 stations of the Third Order, in addition to 30 telegraphic reporting stations and some rainfall stations.

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Organization of stations.

3°. As far as possible the stations of the First Order have been established at existing institutions, in which case a payment is made annually to each institution for carrying on the work. At Valencia the observatory is under the direct management of the Office. The instruments have all been supplied by the Central Office, and include photographic barograph and thermograph, Robinson's anemograph, Beckley's self-recording rain gauge, and other meteorological instruments in use at a first-class observatory.

The caretakers at the anemograph stations receive 10*l.* or 15*l.* a year, except at Alnwick Castle, where the instrument belongs to the Duke of Northumberland, who supplies the records to the office free.

The observers at stations of the Second Order are all volunteers, and observe regularly at 9 a.m. and 9 p.m. The instruments are the property of the observers, and are all duly verified.

The observers at stations of the Third Order are also volunteers, and observe wind, temperature, and sometimes rainfall, once a day. The tables of reduction used at all stations are the "Instructions in the use of Meteorological Instruments," by R. H. Scott, M.A., F.R.S.

With regard to the checking of the returns from the self-recording observatories. The measurements are subjected to a careful examination in order to ensure as far as possible their accuracy, and the regulations which have been adopted to secure this end will be found fully detailed in the Report of the Office for 1868. They comprise rules for the guidance of observers, as well as of the assistants charged with the examination of the work at the Office. The attention of the observers is always drawn to such errors as may be detected, and to any failures in the continuity of the curves arising from failure of the light, stoppage of the clock, defective photography, faulty action of the wet-bulb thermometer, &c.; a report containing the results of the examination of each observatory being also submitted to the Council each month and printed in their minutes.

With regard to the stations at which *direct* observations are made.

All the returns are carefully examined and compared before being copied for the printer. The reduction of all the barometer readings to 32° Faht. at mean sea level is checked, and the corrected readings are then compared with the isobars on the Daily Weather Charts and readings at neighbouring stations, allowance being made for any difference in time and the corresponding change in barometric pressure.

The correction of the readings of the dry-bulb and damp-bulb thermometers is checked, and the maxima and minima temperatures are compared with the dry-bulb thermometer readings over the same periods to ensure that they are the extreme temperatures registered.

The computed values of the vapour tension and the relative humidity are examined from the tables. The cloud amount is compared with the weather at the time of observation, and finally, the sums and means are all re-calculated.

If any readings are doubtful, reference is made through the observer to the original observation book. If no fresh light is thrown on the question by this means, and if on reconsideration the reading still appears to be wrong, it is rejected, and the probable reading is inserted in its place, but printed in different type as an interpolation. These probable readings are used in obtaining the monthly means. Similarly, if from any cause a set of readings has been omitted, the gap is filled by an interpolation, and the probable values are printed in different type.

Special observations.

4°. Special observations of hail, thunderstorms, and periodical phenomena are not regularly made for this Office, except casually by telegraphic

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reporters, but phenological observations are regularly made and published under the auspices of the Meteorological Society.

5°. The method which has been followed by the Office, since its first establishment in 1854 up to the present date, in the collection of information on Ocean Meteorology, has been to supply officers of the mercantile marine with a complete outfit of verified instruments, on the condition of their returning, at the completion of the voyage, the instruments, and the log of observations made with them, to the Office, or to one of its Agents. Marine meteorology.

Every instrument supplied has been originally verified at Kew observatory, and on the completion of the voyage it is compared with a standard instrument either at the Office or by one of its agents. Under ordinary circumstances it is not requisite to send the instruments to Kew for re-verification after every voyage, as the changes in their errors are generally slight.

The regular outfit of a ship consists of:—

1 Barometer (Kew pattern).
6 Thermometers, with a thermometer screen.
4 Hygrometers.

The first record of observations is made in a rough book supplied for the purpose, which is retained by the captain, who copies the observations into a meteorological log kept for the Office.

In order to facilitate communications between the Office and the observers, Agencies are established at some of the principal ports, and instruments are supplied directly from such agencies to the ships.

As regards the Royal Navy, Her Majesty's Ships have been supplied by the Office, since its foundation in 1854, with the meteorological instruments used in the service. The records of observations made by naval officers are in due course deposited at the Admiralty, where they are available for use. It is optional with the observers to keep for the Office a meteorological log in addition to the regular record of observations required by the rules of the service.

Meteorological logs received at the Office, whether from Her Majesty's ships or from the Mercantile Marine, are tested according to a definite form (the "test sheet," which has been published in the Report of the Maritime Conference of London, 1874, p. 35), and the observations are classified according to their quality.

As soon as this first testing has been effected, a letter is written to the captain, and if any questions arise to which he can probably give an answer, he is requested to do so while the incidents are fresh in his memory. The replies are noted in the log for future reference.

In addition to the meteorological logs received from the Navy, a full set of observations is made at one epoch on each day by all of Her Majesty's ships, in whatever part of the world they may be stationed. These are entered on monthly forms, and forwarded to the Office as soon as possible after the end of each month. Officers of the Mercantile Marine who keeping meteorological logs, are also invited to co-operate in keeping the synchronous observations, and in numerous instances the observations are well and regularly made. By these means the Council are in early possession of valuable observations which cover, to some extent, the navigable seas of the Globe.

A special collection is being made of weather observations in the North Atlantic for the 13 months beginning 1st August 1882, and ending 31st August 1883.

The following figures will give an idea of the activity of the marine branch of the Office. The figures refer to the supply of instruments

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for keeping the regular meteorological log, exclusive of synchronous observations:

INSTRUMENTS supplied, &c. to the Royal Navy.

—	Barometers.	Aneroids.	Thermometers.				Hydrometers.
			Ordinary.	Max.	Min.	Screens.	
April 1st, 1883, afloat - -	176	378	1,073	151	153	100	128

INSTRUMENTS supplied, &c. to Mercantile Marine.

—	Barometers.	Thermometers.				Hydrometers.
		Ordinary.	Max.	Min.	Screens.	
April 1st, 1883, afloat - -	140	764	—	—	145	493

The number of regular meteorological logs returned from ships in 1882 amounted to 155, and embraced 765 months of actual observations.

It needs scarcely be said that all such observers are volunteers; their only recompense is a copy of the publications bearing upon ocean meteorology.

Weather telegraphy.

6°. *Telegraphic Weather Service.*—The Office receives, when the telegraphic communications are perfect, 53 reports every morning, 13 every afternoon (except on Sundays), and 19 each evening.

The foreign reporting stations, 23 in number, extend along the entire western coast of the Continent, from Bodö in lat. 67° N. to Corunna in lat. 43° N., and include four stations on the coast of the Baltic, and one in the Mediterranean. The names of these stations are published in the annual reports of the Office.

At the British stations the morning observations are taken at 8 a.m. Greenwich time, and most of the telegrams arrive between 9 and 10 a.m.

The information is entered on a working chart, which shows for each station at 8 a.m. the barometrical and thermometrical readings, with their respective alterations during the preceding 24 hours, the direction and force of the wind, and the state of the weather, together with any changes of importance which may have been noticed in the course of the preceding day. From this chart, which is preserved in the Office, other charts referred to below are then drawn for publication in the newspapers.

Telegraphic *resumés* of the weather, or the actual telegrams, are sent to Copenhagen, Christiania, Hamburg, Jersey, and Paris, and, in the event of stormy weather, to Utrecht also.

A constant watch is kept during the day, and whenever on the receipt of the regular, or of special, telegrams the condition of the weather appears to be threatening, cautionary messages are at once issued to such parts of the coast as are thought to be menaced by a gale.

Forecasts of the weather, for one day in advance, are drawn up for 11 districts in the British Islands, and issued to subscribers, to certain clubs, and to many of the London and Provincial newspapers.

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The forecasts are issued at 11h. a.m. and 8.30 p.m., for publication in the morning newspapers. The average success attained is 76 per cent.

For some years special forecasts have been issued during the hay season, further particulars of which will be found in the Annual Report.

Daily weather charts are lithographed and largely distributed, both to subscribers, and also free for exhibition on the coast and elsewhere.

This lithographed report contains (1) a map of North-western Europe, showing for 8 a.m. on the date of publication the distribution of pressure, the prevalent winds, and the sea disturbance; (2) a similar map showing the distribution of temperature, the weather at each station, and the distribution of rainfall during the past 24 hours; (3) remarks on the principal features exhibited by the reports for the day, with the forecasts drawn up for each district at 11 a.m. relating to the weather likely to be experienced during the 24 hours ending at noon on the day after that of publication; (4) the whole of the reports on the above charts, remarks, and forecasts have been drawn, together with the 2 p.m. and 6 p.m. reports of the previous day.

There is also a Sunday service for the reception of telegrams, and for the issue of storm warnings to the coasts and forecasts for the Monday morning papers.

The Office also issues a Weekly Weather Report, giving the average and extreme temperatures and the rainfall values and the total amount of bright sunshine in each week, for ten districts in Great Britain and Ireland, together with the difference between these and respective mean values for the corresponding weeks in previous years.

The telegraphic reporters are telegraph clerks, schoolmasters, signalmen, and the like, and they receive a remuneration varying from 13*l.* to 20*l.* a year.

A more complete description of the methods followed in this department is published in the Annual Reports.

7°. The Central Office, as stated in § 1°, is divided into three general heads; there is also an administrative department, which attends to correspondence, accounts, library, issue of publications, and all routine matters. The central observatory of the Office at Kew is only distant a few miles, so that only few observations are taken at the Office, which is not sufficiently open for the purpose. The Central Office.

The subordinate stations and supply of instruments have been referred to under other heads.

8°. The staff of the Central Office is composed as follows:— The staff.

I.—*Ocean Meteorology.*

	£
Marine Superintendent - - -	400
Assistant ditto - - -	250
5 Clerks and 2 Boys - - -	483 average for last five years.

During the collection and discussion of the synchronous observations for the North Atlantic, for a year ending 31st August 1883, a special temporary staff has been engaged at a weekly cost of (say) 6*l.* 10*s.* 0*d.*

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II.—*Weather Telegraphy and Signals.*

1 Senior Clerk, 300*l.* and allowance for extra attendance.
6 Clerks - -
2 Boys - - } 1,090*l.* average for last five years.
1 Messenger -

The office hours for this branch are 9 *per diem*, with late evening and Sunday attendance. In other branches of the Office the hours are 8 daily.

III.—*Land Meteorology of the British Islands.*

	£
1 Senior Clerk - - - -	267
6 Clerks - - - -	1,147
1 Engraver - - - -	average for last
5 Boys - - - - -	five years.

IV.—*Administration.*

	£
Secretary - - - - -	800
Chief Clerk - - - - -	333
2 Clerks, 1 Boy, Office Keeper, and Messenger - - - -	385 average for last five years.

This amount is exclusive of the sum paid in fees to the Superintending Council, viz., 1,000*l.* a year.

Departments II., III., and IV. are under the general management of the Secretary.

The payments to the observers at stations have been referred to under other heads.

The stations of the First Order, the seven observatories, receive a regular annual allowance of about 250*l.*; at Valencia the sum is higher. The observers at the stations of the Second Order are all volunteers. The telegraphic reporters are paid as already explained.

Publications.

9°. The list of published books, &c. is printed on the cover of each publication of the Office.

In addition, lithographed Daily Weather Charts and printed Weekly Weather Reports are issued to the number of about 500, more than half of which are distributed free.

The Hourly Readings of Pressure, Temperature (Dry and Wet thermometers), Wind (Direction and Velocity), and Rain at all the seven observatories are printed and distributed with other ordinary publications.

No independent publications are issued by the stations, with the exception of the results of the observations by some of the observatories.

Management and inspections.

10°. The self-recording observatories and the anemographic stations, as well as the telegraphic reporting stations, are regularly visited each year by the inspectors of the Office. The extra stations are inspected as opportunity offers. Of the stations of the Second Order, some belong to the Meteorological Society (of London); these are visited by an inspector appointed by the Society, an allowance being made by the Office towards the cost of the inspection. The remaining Stations of the Second Order, which are in immediate connexion with the Meteorological Office, are visited at least once in every two years by the inspectors of the Office. The Superintendent of the Kew Observatory is especially employed to inspect and report on the self-registering apparatus, and on the photographic processes at the observatories. Extracts from the reports of the inspectors will be found in the Annual Reports.

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Two of the inspectors, viz., for England and Scotland, each receive a salary of 150*l.* a year, in addition to travelling expenses.

11°. There are various establishments and systems in the British Isles not connected with the Central Office, the chief of which are the Observatory of Greenwich, the Radcliffe Observatory, Oxford, and the Bidston Observatory, all of which possess self-recording instruments; and the Meteorological Society, for which a special reply is annexed. The British rainfall system counts as many as 2,000 observers. Supplementary remarks.

The Scottish Meteorological Society also possesses an extensive organisation, details of which are given in the "Journal" published by that society.

In addition to the subjects which fall under the heads above mentioned, the Council give attention to special researches and experiments such as those referring to London fogs, balloon observations, rainfall, hygrometry, atmospheric electricity, &c. Such investigations are usually entrusted to gentlemen outside the Office, who have special knowledge of the subjects in question.

12°. The establishment of the Meteorological Office may be said to be the outcome of the Brussels Conference held in 1853, for, immediately after that meeting, the Royal Society urged upon the Government the importance of a uniform system of meteorological observations at sea. In 1854 the President of the Board of Trade resolved to establish a Meteorological Department in connexion with the Marine Department of that office, and appointed Admiral (then Captain FitzRoy) as its chief. Admiral FitzRoy began work on a very comprehensive scale, and worked vigorously in the branch of ocean meteorology until 1860, when his attention was turned to weather telegraphy. To him is mainly due the credit of establishing the now general system of storm warning signals. He died in 1865, and in 1867 the Government placed the management of the Office under a Committee of the Royal Society with a grant of 10,000*l.* a year and free printing. This Committee continued the work of Admiral FitzRoy in branches I. and II., and added No. III. (Land Meteorology). The chairman of this Committee was Sir E. Sabine. In 1877 the Office was reconstituted, and placed under the management of the Meteorological Council, who are nominated by the Royal Society and appointed by the Government, and dispose of an annual grant at present amounting to 15,300*l.* The first chairman of the Council was Professor H. J. S. Smith, F.R.S., in whose recent death the Office has sustained a very serious loss. The Royal Society have now (March 1883) nominated Lieutenant-General R. Strachey, C.S.I., F.R.S., as chairman of the Council. Historical.

B.—*Meteorological Society, London.*

1. The stations in connexion with the Meteorological Society were organised with the view of furnishing trustworthy data for determining the climate of the British Isles. Definition of system.

2. The number of stations in 1882 were 25 Second Order and 64 climatological (Third Order). Number and position of stations

3. At the Second Order Stations the hours of observation are 9h. a.m. and 9h. p.m. local time. The maximum and minimum thermometers are read and set at 9h. p.m., and the readings entered to the day on which they are read. Organization of stations.

At the Climatological Stations the observations are made once each day, viz., at 9h. a.m. The reading of the maximum thermometer is entered to the previous day, but the reading of the minimum is entered to the day on which it is read.

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The instructions issued to the observers are those contained in "'Hints to Meteorological Observers, with Instructions for taking "'Observations and Tables for their Reduction.' Prepared under the "direction of the Council of the Meteorological Society by William "Marriott, Assistant Secretary," London, 1881.

All the observations are scrupulously examined, the readings at each station are first carefully compared with those at the adjacent stations, and then the readings on the return are examined *inter se*. The corrections, calculations, and reductions are also checked, all the work being gone over by two separate computers.

Special observations.

4. Special observations of phenological phenomena are made at 47 stations, and the results discussed by the Rev. T. A. Preston in an annual report, which is published in the "Quarterly Journal." The list of plants, insects, birds, &c., to be observed is given in the "Instructions for the Observation of Phenological Phenomena," 2nd edition, London, 1883.

Marine observations.

5. No observations are made at sea for the Society, but papers based on such observations are occasionally read at the meetings and printed in the "Quarterly Journal."

Weather telegraphy.

6. There is no telegraphic weather service in connexion with the Society.

The Central Office.

7. The Society's Office is at No. 30, Great George Street, Westminster.

The observers are nearly all volunteers, and provide their own instruments.

The staff.

8. The staff consists of the assistant-secretary, with a salary of 155*l*., and three computers, whose pay in 1882 amounted to 101*l*. 8*s*.

All the observers give their services gratuitously except one, who receives a small payment.

Publications.

9. The Society issues two publications, viz.:—

1. "The Quarterly Journal," which contains the papers read at the meetings, abstracts of the discussions, the Proceedings of the Society, and other information; and
2. "The Meteorological Record," which contains the monthly results of observations made at the stations of the Meteorological Society, with remarks on the weather for each quarter.

Management and inspections.

10. The Council exercise a general supervision over the stations, which are inspected by the assistant-secretary every two years, those in the north being visited one year and those in the south the next. The reports on the inspection are published in the "Quarterly Journal."

Supplementary remarks.

11. Copies of the daily observations from 14 stations are supplied to the Meteorological Office for publication in full in the "Meteorological Observations at Stations of the Second Order."

Historical.

12. In 1874 the Society commenced the organisation of a series of Second Order Stations, at which the observations are made on a uniform plan, so that the results might be strictly comparable with each other.

In addition to these, another class of stations was started on January 1, 1880, viz., the climatological, at which observations of the dry bulb, wet bulb, maximum and minimum thermometers, amount of cloud, rainfall, and weather, are made once daily at 9 a.m.

C.—*W. H. M. Christie, Astronomer Royal, Royal Observatory, Greenwich.*

In the Meteorological Section of the Magnetical and Meteorological Department of the Royal Observatory, continuous photographic record is maintained of the barometer, of the dry bulb and wet bulb thermo-

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meters, and of Thomson's electrometer; also continuous automatic record of the direction and pressure of the wind, and rainfall (by Osler's anemometer), of the horizontal movement of the air (by Robinson's anemometer), of the duration of sunshine (by Campbell's instrument), and of the amount of ozone.

Eye observations of the standard barometer and of the standard dry bulb and wet bulb thermometers are taken daily at 9 a.m., noon, 3 p.m., and 9 p.m.; also observations of self-registering maximum and minimum thermometers, and of thermometers for solar and terrestrial radiation. Earth thermometers (four, having bulbs respectively 24, 12, 6, and 3 French feet below the surface) are read daily at noon. Rain gauges on the ground and at different elevations up to 51 feet are read daily.

A general record of atmospheric changes is kept, and numerical estimations of the amount of cloud are made at 9 a.m., noon, 3 p.m., and 9 p.m.

Results deduced from these records and observation are published annually (with those deduced from the magnetic observations) in the Magnetical and Meteorological Section of the Greenwich Observations.

Regular observations of the principal magnetical and meteorological elements were commenced at the Royal Observatory in the year 1840; the photographic process was introduced in the year 1848.

The Magnetic and Meteorological Department of the Royal Observatory is under the direction of the Astronomer Royal. The staff of the department consists of a superintendent, with salary ranging from 320*l.* to 450*l.*, and one assistant, with salary ranging from 180*l.* to 250*l.* An annual sum of 230*l.* is allowed for the employment of computers.

D.—*G. M. Whipple, Kew Observatory, Richmond, Surrey.*

In reply to your circular of the 31st December 1882, I have the honour to inform you that this establishment has had no independent meteorological organisation since 1867, at which time it became one of the first-class stations of the Meteorological Committee, and remains so at the present date.

This does not, however, apply to the magnetical branch of the Observatory work, which since 1871 has been conducted under the auspices of a committee of the Royal Society.

GREAT BRITAIN AND IRELAND. COLONIES. A.—CANADA

C. Carpmael, Esq., Meteorological Office, Toronto.

I have much pleasure in forwarding the following statement in reply to your circular dated December 31st, 1882 :—

1. The meteorological system of Canada comprises— Definition of system.
   - (i.) A central office entrusted by the Government with the management, collection, and publication of the meteorological observations of the country and the issue of weather forecasts and storm warnings.
   - (ii.) A number of observing, and
   - (iii.) Publishing stations.

2. Of the observing stations there is but one that answers to the definition of a Station of the First Order contained in Appendix I. to the Protocol of the Ninth Meeting of the Vienna Conference, but there are ten others at which observations more or less are taken at regular Number and position of stations.

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intervals, six, ten, or twelve times per day as under. (See **List of Stations.**)

There are 82 Stations of the Second Order; and there are 91 **Stations** of the Third Order.

This does not include stations which merely send in storm **reports** or short statements of weather, used in ascertaining how far the **weather** predictions are fulfilled.

The following is the list of stations:—

METEOROLOGICAL SERVICE. DOMINION OF CANADA.

STATIONS of the FIRST ORDER, or partially so.

Stations.	Lat.	Long.	Remarks, Hours of Observation, &c.
	° ′	° ′	
Toronto (Central Office) -	N43 39	W19 23	Self-recording magnetographs, thermograph, barograph, anemograph, and sunshine recorder. Eye observations each second hour, from 6 a.m. to midnight inclusive. Three daily observations for weather telegraphy. Daily observation of actinometer, sunshine recorder. Monthly determination of magnetic dip. Intensity and declination.
Sydney, N.S. - -	46 8	60 10	Full observations each second hour. Self-recording anemograph. Sunshine recorder.
Halifax, N.S. - -	44 39	63 36	Full observations each third hour. Self recording anemograph. Three daily observations for weather telegraphy.
St. John, N.B. - -	45 17	66 3	Observations for temperature every second hour. Other observations six times daily. Self-recording anemograph.
Fredericton, N.B. -	45 57	66 38	Full observations at each third hour. Self-recording anemograph. Sunshine recorder.
Montreal - - -	45 30	73 35	Full observations at every fourth hour. Self-recording anemograph. Sunshine recorder.
Quebec - - -	46 48	71 12	Observations for temperature every second hour. Extremes. Rain, &c. Self-recording anemograph.
Kingston - . -	44 14	76 29	Observations for temperature every second hour. Extremes. Rain. &c.
Woodstock - - -	43 8	80 47	Observations for temperature at each third hour. Other observations three times daily. Self-recording anemograph. Sunshine recorder.
Winnepeg (Man.) - -	9 55	97 7	Full observations at each third hour. Self-recording anemograph. Sunshine recorder.
Westminster, B.C. -	49 12	122 53	Full observations at each third hour.

STATIONS of the SECOND ORDER.

(*) Have not been supplied with barometer.
(*a*) Take an extra observation for international bulletin.

Station.	Lat.	Long.	Unless otherwise stated, Observations are made at 7 a.m., 2 and 9 p.m., Local Time.
NEWFOUNDLAND:	° ′	° ′	
St. John's - -	N47 34	W52 42	8.37 a.m., 4.37. p.m., 8.37 p.m.
St. Pierre (*a*) -	46 47	56 12	10 a.m., 4 p.m.
Notre Dame Bay -	50	57	8 a.m., 2 and 8 p.m.
Chanvel - - -	47 34	59 7	8 a.m., 2 and 9 p.m.
NOVA SCOTIA:			
Baddeck - - -	46 6	60 49	8 a.m., 2 and 9 p.m.
Picton - - -	45 42	62 41	——
Truro - - -	45 22	63 18	——
Windsor (*a*) - -	44 59	64 6	Self-recording anemograph, and self-recording rain gauge.
Yarmouth - -	43 50	66 2	6.50 a.m., 2.50 and 10.50, Toronto time.
New Glasgow (*) -	45 41	66 39	——
NEW BRUNSWICK:			
Bird Rocks (Magdalen Islands).	47 51	61 8	6.50 a.m., 2.50 and 10.50 p.m., Toronto time.
Bathurst (*a*) - -	47 39	65 42	7.45 a.m., 2 and 7 p.m.
Chatham - - -	47 3	65 29	6.50 a.m., 2.50 and 10.50 p.m., Toronto time.
Dalhousie (*a*) - -	48 4	66 22	——
Point Le Preaux (*) -	45 4	66 27	——
St. Andrews - -	45 5	67 4	6.50 a.m., 2.50 and 10.50 p.m., Toronto time.

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STATIONS of the SECOND ORDER.—*continued.*

Station.	Lat.	Long.	Unless otherwise statad, Observations are made at 7 a.m., 2, and 9 p.m., Local Time.
	° ′	° ′	
PRINCE EDWARD'S ISLAND:			
Charlottetown	46 14	63 10	6.50 a.m., 2.50 and 10.50 p.m., Toronto time. Self-recording anemograph.
Kilmahumaig (*)	46 48	64 2	10 a.m., 4 and 10 p.m.
QUEBEC:			
Anticosti	49 24	63 36	6.50 a.m., 2.50 and 10.50 p.m., Toronto time.
Chicontimi	48 25	71 5	———
Cranbourne	46 22	70 37	———
Danville (*)	45 47	72 1	———
Father Point	48 51	68 28	6.50 a.m., 2.50 and 10.50 p.m., Toronto time.
Huntingdon	45 5	74 10	———
Quebec Obsy	46 48	71 13	6.50 a.m., 2.50 and 10.50 p.m., Toronto time.
Richmond (*)	45 40	72 88	———
HUDSON'S BAY:			
Fort Albany	52 12	82 5	8 a.m., 2 and 7 p.m.
Moose Fort (*a*)	51 16	82 56	———
York Factory (*a*)	57 0	92 26	———
Marten's Falls	51 30	86 30	7 a.m., 2 and 7 p.m.
ONTARIO:			
Birnam	43 2	81 55	———
Bancroft	45 1	77 50	———
Barrie	44 53	79 40	7 a.m., 1 and 9 p.m. Sunshine recorder.
Beatrice (*)	45 8	79 20	———
Brampton (*)	43 41	79 46	———
Conestogo	43 33	80 31	———
Cornwall (*a*)	45 1	74 43	7 a.m., 1 and 9 p.m. (Sunshine recorder.)
Durham (*)	44 10	80 50	———
Desoronto	44 11	77 4	———
Egremont (*)	44 0	80 57	———
Fitzroy Harbour	45 30	76 14	———
Goderich	43 45	81 43	7 a.m., 1 and 9 p.m.
Granton (*a*)	43 12	81 21	———
Gravenhurst (*)	44 54	79 20	———
Guelph	43 33	80 16	———
Hamilton (*a*)	43 16	79 53	7 a.m., 1 and 9 p.m.
Huntsville	45 30	79 8	———
Kincardine	44 11	81 37	7 a.m., 11 p.m.
Kingston	44 14	76 29	6.50 a.m., 2.50 and 10.50 p.m., Toronto time. Sunshine recorder.
Lindsay	44 20	78 45	Sunshine recorder.
Mount Forest (*a*)	43 58	80 44	———
Mamainse	47 30	84 50	———
Ottawa	45 26	75 41	7 a.m., 1 and 9 p.m.
Parry Sound	45 19	80 00	6.50 a.m., 2.50 and 10.50 p.m., Toronto time. Self-recording anemograph.
Pembroke	45 50	77 7	7 a.m., 1 and 9 p.m. Sunshine recorder.
Peterborough (*a*)	44 17	78 18	Do.
Penetanguishew	44 45	79 56	———
Point Clark (*)	44 5	81 44	———
Port Dover	42 47	80 13	6.50 a.m., 2.50 and 10.50 p.m., Toronto time.
Port Stanley	42 40	81 13	Do. Self-recording anemograph.
Prince Arthur's Landing	48 27	89 12	Do. do.
Rockliffe	46 12	77 55	Do.
Saugeen	44 30	81 21	6.50 a.m., 2.50 and 10.50 p.m., Toronto time.
Simcoe	42 50	80 21	7 a.m., 1 and 9 p.m.
Stratford (*a*)	43 23	81 0	Do. Sunshine recorder.
Strathroy	42 56	81 42	———
Welland (*)	42 59	79 17	7 a.m., 1 and 9 p.m.
Windsor	42 19	83 2	Do. Sunshine recorder.
MANITOBA AND NORTH-WEST TERRITORY:			
Winnipeg	49 53	97 7	———
Poplar Heights	50 4	97 47	7 a.m., 1 and 9 p.m.
Stoney Mountain	50 5	97 12	———
Rapid City	50 7	100 0	———
Oak Lake	49 45	100 35	8 a.m., 1 and 9 p.m.
St. Andrew	50 5	97 0	———
Battleford	52 41	108 30	1 p.m., 9 p.m.
Fort Calgary	50 55	113 45	8 a.m., 2 and 9 p.m.
Edmonton	53 14	113 38	0.26 p.m., 8.23 p.m.
Humbolt	52 12	105 10	1.7 p.m., 9.7 p.m.
Munnedosa	50 14	99 47	5.27 a.m., 1.27 and 9.27 p.m.
Fort Dunvegan (*)	56 ?	118 20	———
B.C. Spence's Bridge (*)	50 25	121 30	7 a.m., 1 and 9 p.m.
B.C. Grand Prairie (*)	50 28	119 48	7 a.m., 1 and 8 p.m.

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Stations of the Third Order.

(*b.*) Supplied with Maximum and Minimum Thermometers.

Station.	Lat.	Long.	Remarks.
	° ′	° ′	
Cow Bay	N 46 8	W 59 52	——
Little Glace Bay (*a*)	46 12	59 58	——
White Point	46 52	60 22	——
Broad Cove (*b*)	46 17	61 12	——
Port Hastings	45 39	61 24	——
Antigonistic (*b*)	45 38	61 59	——
Dorchester	45 55	64 32	——
Moncton (*b*)	46 6	64 49	——
Hampton	45 33	65 50	——
St. François (*b*)	46 13	70 48	——
Barnston	45 6	71 28	——
Brome (*b*)	45 12	72 34	——
L'Original (*b*)	45 38	74 42	——
Lodi	45 12	75 2	——
Lunenberg	45 4	75 2	——
Edwardsburg	44 50	75 25	——
Metcalfe	45 16	75 28	——
Augusta	44 47	75 42	——
Merrickville	44 57	75 52	——
Addison	44 41	75 54	——
Renfrew	45 26	76 39	——
Northcote (*b*)	45 30	76 46	——
Newburgh	44 19	76 53	——
Clontarf	44 23	77 9	——
Norwood (*b*)	44 22	77 59	——
Lakefield (*b*)	44 25	78 15	——
Port Hope	43 56	78 20	——
Ennismore	44 23	78 27	——
Mattawa (*b*)	46 15	78 41	——
Hampton	43 57	78 47	——
Oshawa (*b*)	43 33	78 52	——
Kirkfield	44 32	78 57	——
Brechin (*b*)	44 30	79 10	——
Bracebridge	45 1	79 17	——
St. Catherine's	43 10	79 17	Sunshine Recorder.
Georgina	44 19	79 18	——
Orillia	44 34	79 24	——
Newmarket	44 2	79 29	——
Port Credit	43 34	79 36	——
North Glanford	43 11	79 57	——
Georgetown	43 39	79 58	——
Brantford (*b*)	43 10	80 21	——
Fergus	43 42	80 24	——
Otterville	42 57	80 37	——
Owen Sound (*b*)	44 34	80 55	——
Presque Isle	44 42	80 55	Anemometer.
Ingersoll	43 2	80 57	——
Listowell	43 44	80 58	——
St. Thomas	42 47	81 13	——
Brussels	43 44	81 14	——
Wilton Grove	42 56	81 17	——
Egmondville	43 31	81 25	——
Delaware	42 53	81 26	——
Seaforth	43 32	81 26	——
Lucan	43 10	81 27	——
Hensall	43 25	81 32	——
Ailsa Craig	43 8	81 36	——
Zurich (*b*)	43 24	81 38	——
Colborne	43 45	81 38	——
Glencoe	42 45	81 43	——
Goderich and House	43 45	81 43	Anemometer.
Thamesville	42 32	82 1	——
Florence	42 39	82 1	——
Sarmia	42 59	82 24	——
Stoney Point	42 19	82 33	——
Cottam	42 7	82 45	——
Tecumsek	42 19	82 54	——
Maidstone	42 13	82 54	——
Amherstburg	42 6	83 7	——
Nicola Lake	50 16	120 43	——
Cache Creek	50 49	121 27	——
Hope	49 23	121 28	——
Douglas Lake	50 37	121 30	——
Lillooet (*b*)	50 42	122 2	——
Soda Creek (*b*)	52 20	122 19	——
Langley	49 11	122 32	——

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STATIONS of the THIRD ORDER.—*continued.*

Station.	Lat.	Long.	Remarks.
	° ′	° ′	
Clinton	51 6	122 48	——
Ladwen Landing (*b*)	49 6	123 4	——
Heath Point } Anticosti	49 5	61 43	Tri-daily observations of temperature, weather, directions, and character of wind, rain, fog, &c. are furnished by these light-house stations monthly.
West Point } Anticosti	49 52	64 32	
Cape Magdalen	49 16	65 20	
Cape Chalte	49 6	66 45	
Point des Monts	49 20	67 22	
Bicquet	48 25	68 53	

All Stations report as to Thunder, Lightning, Aurora, Seasonal Events, &c.

Meat Cove, C.B.	46 58 ?	60 26 ?	Reports are received by telegraph twice daily from these stations as to weather, wind, fog, and ice in the spring of the year.
Etang du Nord	47 24	61 57	
Grosse Isle, N. extremity of Magdalen Island.	?	?	
Amherst Isle	47 13	61 58	
East point Anticosti	49 5	61 43	
West point Anticosti	49 52	64 32	
Cape Rosier	48 52	64 12	

3. At each station of the First Order there is a superintendent and two or three assistants, paid from the Central Office. Organization of stations.

The stations of the Second Order are for the most part unpaid, and no regular assistants are employed except at a few stations in connexion with the telegraph system. The hours of observation at these stations are 7h. a.m., 2h. p.m., and 9h. p.m., local time, except where otherwise stated in the above list. (See 2.)

The Stations of the Third Order are all volunteer stations, and except where otherwise stated in the above list, the observations are only of rain and general phenomena, the measurements for rain being taken at 7h. a.m.

The Instructions supplied to the observers are those issued by this office. They agree substantially with there commendations of the Vienna Conference.

The psychrometrical tables employed are taken from the Smithsonian meteorological tables, except those for the humidities at low temperatures, which have been calculated in the Central Office for every tenth of a degree of difference between the wet and dry thermometers from the data given by Regnault in his "Rélations des Expériences."

The reduction of the barometer to sea-level is effected by means of tables calculated for each station (generally for every second degree of temperature and every two-tenths of an inch of the barometer) by means of the formulæ contained in a paper "On the Reduction of the Barometer to Sea-Level," by Charles Carpmael, which are based on La Place's formulæ, the barometric constant being taken as 60345·51 English feet, and the coefficient for the expansion of air as $\frac{1}{459}$.

On the receipt at the Central Office, the weekly and monthly abstracts from the different stations are subjected to an examination

(i.) As to any apparently improbable entries,
(ii.) By comparison with other stations,
(iii.) As to the proper application of index correction, reduction to 32°, and sea-level, and ordinary arithmetical errors.

4. Special observations, such as of thunderstorms, hail, periodical Special observations.

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phenomena, the return of the seasons, &c. are taken at all the above 183 stations.

Marine observations. Weather telegraphy.

5. No observations at sea.

6. Telegraphic reports are received in cypher at the Central Office three times a day of the readings of the barometer (reduced to sea-level), the temperature of the air, the dew-point, the state of the weather, the direction and velocity of the wind, the kind, amount, and direction of motion of the upper and lower clouds, the amount of rainfall during the preceding eight hours, and in the morning the lowest temperature since last report.

The stations in Canada which send the three reports are Sydney, Halifax, and Yarmouth, N.S., Chatham, N.B., South-West Point, Anticosti, Father Point, Quebec, and Montreal (Quebec), Rockliffe, Kingston, Toronto, Port Stanley, Saugeen, Parry Sound, Prince Arthur's Landing (Ont.), Winnipeg (Man.), and Charlottetown (P.E.I.), send the morning report only. Telegrams are also received every morning from seven stations on the Gulf of St. Lawrence, giving the direction and estimated force of the wind and the state of the weather; in the spring the amount and direction of flow of the ice is added. These seven stations are—Meat Cove, N.S., Etang Du Nord, Grosse Isle, Amherst Island in the Magdalen Islands, East Point and West Point, Anticosti, and Cape Rosier, Quebec.

In addition to these reports from Canadian stations, reports are received in the morning from 61, in the afternoon from 44, and in the evening from 49 stations of the United States Signal Service.

The observations on which these reports are based are taken at 6.50 a.m., 2.50 p.m., and 10.50 p.m., Toronto civil time.

The reports as soon as received are charted, and probabilities made out for the ensuing 24 hours; and in cases where it is deemed practicable the probabilities have been extended for two or three days. The probabilities made out at midnight are given to the Associated Press for publication in the morning papers, and are also posted up at every telegraph office and railway station in the country (about 1800). A sufficient number of the bulletins for the purpose of verification after having been posted are forwarded to the Central Office with a short notice on the back showing how far the actual weather experienced has agreed with the forecasts. The probabilities made out from the morning map are forwarded to the Associated Press for publication in the afternoon papers. Those made out from the afternoon map are not published, the reports being only used for purposes of storm warnings and for answers to special inquiries.

Warnings of storms are issued when deemed necessary to the following ports :—

Inland Lakes Stations.

Collingwood.	Port Dover.
Midland.	Port Culhorne.
Owen Sound.	Port Dalhousie.
Presqu' Isle.	Burlington Beach.
Saugeen.	Oakville.
Kincardine.	Port Credit.
Bayfield.	Toronto.
Goderich.	Cobourg.
Tanna.	Port Hope.
Port Burwell.	Kingston.
Amherstburg.	Picton.
Port Stanley,	Deseronto.

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St. Lawrence River and Gulf.

Montreal.	Chatham.
Quebec.	Charlottetown.
Father Point.	Pictou.
Gaspé.	Point du Chêne.
Persé.	Dalhousie.
Bathurst.	

Atlantic Sea Coast.

North Sydney.	Liverpool.
Louisburg.	Yarmouth.
Cow Bay.	Digby.
Glace Bay.	St. Andrews.
Port Hastings.	Point le Preaux.
Halifax.	St. John.

The warnings are signalled by means of drums and cones, and are arranged to indicate the direction as well as the force that is expected as per code appended hereto. In addition to this publication by signal, written notices are posted giving more detailed information as to the expected changes in the wind and weather.

DIRECTIONS TO MARINERS with reference to CANADIAN STORM WARNINGS, issued for QUEBEC and the MARITIME PROVINCES.

FIG. No. I., Cone inverted.—This signal indicates "*moderate gale* is expected probably *at first* from an easterly direction."

FIG. No. II., Cone upright.—This signal indicates "*moderate gale* is expected probably *at first* from a westerly direction."

FIG. No. III., Drum above inverted cone.—This signal indicates "*Fresh to heavy gale* is expected probably *at first* from an easterly direction."

FIG. No. IV., Drum below upright cone.—This signal indicates "*Fresh to heavy gale* is expected probably *at first* from a westerly direction."

The *Cone*, when hoisted by itself, indicates that it is expected that the wind will attain a velocity of 30 miles an hour, but will not exceed 40 miles; and it is not intended than an ordinarily well found vessel should stay in port, but simply as a warning to mariners that strong winds are expected from the quarter indicated.

The *Drum* will always be hoisted when the velocity of the wind is expected to exceed 40 miles an hour.

The night signal, corresponding to Nos. 1 and 3, is two white lanterns *hanging perpendicularly.*

The Night signal, corresponding to Nos. 2 and 4, is two white lanterns *hanging horizontally.*

NOTE I.—Mariners will be able to obtain further information from Drum Agents, or by consulting the daily probabilities.

NOTE II.—Mariners must always bear in mind that the storm signals are merely *cautionary* and do not necessarily mean that a storm will occur at the place where the signal is displayed, but that one is expected either there or within such a distance that vessels leaving port would be liable to be caught in it.

NOTE III.—The new signals will be issued and used at all Canadian Storm Signal Stations in Quebec and the Maritime Provinces on and after July 15 next.

C. CARPMAEL.

Meteorological Office,
Toronto, July 1, 1882.

During the winter warnings, are telegraphed to the managers of all the railways in the country, when heavy snowstorms or much drifting of

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snow is expected. Occasionally during the harvesting season extended predictions have been issued for the benefit of farmers for as much as three days in advance.

The Central Office.

7. The Central Office of the system is stationed at Toronto.—The staff consists of a superintendent, deputy superintendent, three observers, an inspector, two probability officers, one photographer, and three clerks, besides office boys, who are employed in copying, and a messenger. There are also two telegraphic operators.

The office is situated in the grounds of the Magnetic Observatory, the director of which is also the superintendent of the meteorological system. The three observers above mentioned are also on the observatory staff.

There are no subordinate centres for management and collection of observations, the whole of the observations being sent direct to the Central Office, where all the work is supervised, sums and means obtained, and results compiled for publication. The Central Office also undertakes to supply instruments and stationery to all stations of the system. The instruments are tested and compared with standards at the observatory.

The Staff.

8. The pay of the staff at the Central Office is as follows:—

	$
*Superintendent - - - -	400·00
3 Observers, $500, 400, $300 - -	1200·00
Deputy superintendent - - -	1000·00
Inspector - - - -	800·00
2 Probability officers, $700 and $680 -	1380·00
Photographer - - - -	570·00
3 Clerks, $500, $550, $432 - -	1482·00

At first-class stations the pay for superintendent and assistants varies from $740 to $400.

Publications.

9. The publications issued by the Central Office are:—

"Monthly Weather Review."
"Annual Report."
"Annual Comparative Table."

In addition to these, monthly and quarterly tables are compiled in the Central Office for the Ontario Bureaus of Industries, and a weekly resumé for the Board of Health, which tables are published in the reports of these bodies.

The independent publications of the principal stations are:—

Montreal, monthly abstract of principal daily readings.
St. John N.B., annual statement.
Halifax do. do.
Charlottetown do. do.

Management and inspections.

10. The control of the whole system is entrusted to the superintendent, and the stations are inspected as often as is found practicable, either by the superintendent, deputy-superintendent, or inspector. The stations in British Columbia, Manitoba, and the far North West, with the exception of Fort Garry, Minnedosa, Oak Lake, Stoney Mountain, and Rapid City, have never been inspected; the instructions having been given entirely by the printed volume, supplemented by letters when necessary.

Historical.

12. Historical Summary (1869 to 1871).—In the latter part of the year 1869, Professor Kingston, Director of the Magnetic Observatory, Toronto, addressed himself by letter and circular to those already taking

* The superintendent also receives a salary as Director of the Magnetic Observatory, and the three observers are likewise on the observatory staff.

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meteorological observations in various parts of the country, and to those thought likely to take part in the work, requesting their co-operation with a view to organising some regular system.

From October 1869 until the spring of 1871 meteorological work in Canada was carried on by volunteer organisation, and the instruments were either provided from private sources, or lent from the observatory, Toronto. The work of organising new stations as well as of discussing and compiling the observations was performed gratuitously by the director and assistants of the observatory.

(1871).—In the spring of 1871 a grant of $5,000 was obtained from the Government; the greater part of this was appropriated in the establishment of five chief stations, the remainder to the purchase of instruments for ordinary stations, and for stationery, printing instructions, forms, &c. This grant was afterwards supplemented, and the total expenditure for the fiscal year ending June 30th, 1872, amounted to $7,870.

(1872.) In the year 1872 a few stations began to report three times a day to Toronto by telegraph. These reports, together with that from Toronto, were forwarded regularly by telegraph to Washington, and in return reports from 15 stations in the United States were forwarded to Toronto. The Washington office also undertook to furnish warnings of storms approaching the inland lakes and the Canadian Sea Coast.

The Parliamentary grant for the year ending June 30th, 1873, was $10,000.

(1873.) Three stations in Canada were added in 1873 to the list of those reporting by telegraph to Toronto, and the reports from the United States were received twice, instead of once a day.

The Parliamentary vote for the year July 1st, 1873, to July 1st, 1874, was $37,000,

(1874.) In 1874 thirty-five stations were provided with masts and drums for the display of storm-warning signals.

(1876.) During the summer, and until the close of navigation, a weather chart was issued daily, and was posted up at the Marine Exchange Board, Toronto.

In the beginning of September 1876, arrangements having been made with the Chief Signal Officer, Washington, whereby reports from a much larger number of stations in the United States were forwarded to Toronto three times a day, this office began to issue its own warnings instead of depending upon the Washington Office.

Daily forecasts were regularly furnished to the Toronto papers from October of this year, and from December to the telegraph companies, who forwarded them to the various newspapers in Ontario and in Montreal.

(1877.) In January 1877, a "Monthly Weather Review" was first issued towards the end of the year, the daily weather forecasts were furnished by telegraph to 95 stations in various parts of the Dominion.

(1880.) On January 31st, 1880, Professor Kingston, who had had the superintendence of the service from its first establishment, was compelled through failing health to retire, and was succeeded by Mr. Charles Carpmael. During 1880 arrangements were made with several railway companies for posting forecasts at all their stations; and with others for posting them at their principal stations only. The number of telegraph offices at which the forecasts were posted was also increased to 300, and, for the first time, predictions, extending over two or three days, were issued for the benefit of farmers.

(1881.) In July 1881, a system of storm warnings was inaugurated on the inland lakes, whereby the direction as well as the approximate force of the wind is indicated.

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(1882.) In 1882 arrangements were made with telegraph companies whereby forecasts issued at midnight are posted early in the morning at every telegraph station (about 1,800) in the country. In the month of July of the same year the new system of storm warnings was extended to the sea-coast. These measures greatly increased the interest taken by the public in the work of the office, and the number of volunteer observers has since been rapidly and steadily on the increase.

The Parliamentary vote, which had been for several years $37,000, was for the fiscal year beginning July 1882 increased to $40,000.

GREAT BRITAIN AND IRELAND. COLONIES. B.—CAPE OF GOOD HOPE.

W. Ellerton Fry, Esq., Meteorological Commission, Cape of Good Hope.

At the request of the members of the Meteorological Commission I beg to send you the following information in reply to your circular of 31st December 1882:

Definition of system.

1. The Meteorological Commission is an honorary body appointed by the Colonial Government. The funds at the disposal of the Commission were until recently 250*l.* per annum, which small sum had to suffice for purchase of instruments and salary of secretary. During the last three years an extra sum of 250*l.* per annum has been voted to enable the secretary to make a tour of inspection of stations, and in 1882 a special vote of 100*l.* was made to defray the expense of purchasing some self-recording instruments. Many of the rain-gauge stations are at gaols, and the gaoler is instructed by Government that it is part of his duty to read the gauge.

The meteorological system in Cape Colony consists of (i.), our well-equipped station, the Royal Observatory supported by the Imperial Government. (ii.) A varying number of stations in the colony supplied with instruments by the Meteorological Commission of the colony. (iii.) A large number of stations supplied by the Crown Lands and Public Works Department, with rain-gauges only.

Number and position of stations.

2. The geographical positions are given in the Annual Report of the Meteorological Commission.

Organization of stations.

3. Hours of observation at Royal Observatory, 6h. a.m., 1h.22m. p.m., and 10h. p.m.; elsewhere generally 8h. a.m. and 8h. p.m. Copy of instructions to observe is enclosed herewith. Some tables of reduction are given in the annual report.

Weather telegraphy.

6. Under consideration.

The Central Office.

7. The Royal Observatory is, by permission of the Astronomer Royal of the Cape, the Central Office.

The staff.

8. The observers gave their services *gratis*.

Publications.

9. The Commission publish a report once a year. The late Astronomer Royal here, Mr. Stone, published results of the records of the Royal Observatory.

Management and inspections.

11. The secretary of the Commission inspects as far as practicable all stations once a year.

Historical.

12. From 1862–1868 a Commission was in existence which published reports. From 1868–1875 the Commission did not print any report. The present system began in 1875 and the annual reports if examined consecutively show a progressive increase in number of observations. Since the organisation of inspection it is believed that the quality of the observations has been improved.

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GREAT BRITAIN AND IRELAND. COLONIES. C.—CEYLON.

J. Stoddart, Esq., Surveyor General's Office, Colombo, Ceylon.

Definition of system.

1. Complete meteorological observations are taken at thirteen stations in Ceylon; three of which are inland hill stations, two inland stations in the low country and eight coast stations. Partial observations are taken at one inland station on the plains. Rainfall only is registered at 55 stations. These observations are forwarded monthly to the head office in Colombo where the monthly averages are tabulated and published.

Number and positions of stations.

2. The whole of the Ceylon stations are of the Second Order, and are situated as follows:—

——	Lat.	Long.	Height.	—
	° ′	° ′	Feet.	
Colombo	6 56	N. 79 59 E.	40	Coast.
Ratnapura	6 42	„ 80 24 „	109	Inland.
Puttalam	8 2	„ 79 50 „	11	Coast.
Anuradhapura	8 22	„ 80 23 „	312	Inland.
Mannar	8 59	„ 79 55 „	12	Coast.
Jaffna	9 40	„ 79 56 „	9	„
Trincomalee	8 33	„ 81 15 „	175	„
Batticaloa	7 43	„ 81 44 „	26	„
Hambantota	6 7	„ 81 7 „	40	„
Galle	6 1	„ 80 14 „	48	„
Kandy	7 18	„ 80 40 „	1,650	Hill.
Nuwara Eliza	6 59	„ 80 5 „	6,240	„
Badulla	6 59	„ 81 5 „	2,225	„
Vavonia Vilan Kulam	?	?	?	Inland.

Organization of stations.

3. The observations taken daily at 9h.30m. a.m. and 3h. 30m. p.m., are entered into a rough book from which the monthly sheet, almost similar to the form published in Colonel Sir Henry James' Instructions for taking Meteorological Observations, is prepared. Instructions prepared by Colonel Fyers, R.E., are supplied to the observers. Glaisher's tables are used for the reduction of the observations.

The rough books and monthly sheets are forwarded to the head office at Colombo, where they are checked and compared.

Special observations.

4. Thunderstorms and other phenomena are noted in the remarks attached to the monthly sheets. A complete return of thunder and lightning seen or heard at Colombo, is forwarded monthly to Mr. G. J. Symons, of 62, Camden Square, London.

Weather telegraphy.

6. Daily weather telegrams are forwarded to Simla, from May 16th to October 15th, and to Calcutta, from 16th October to 15th May, at 9½ a.m., from Colombo, Galle, and Trincomalee, by the ordinary Government service.

Daily weather telegrams are forwarded to the General Post Office at Colombo from 10 stations, viz., Colombo, Anuradhapura, Mannar, Jaffna, Trincomalee, Batticaloa, Galle, Kandy, Nuwara Eliza, and Badulla, and published by the Government in the Daily Postal List, and in the local newspapers.

The Central Office.

7. The Central Office is the Surveyor General's Office at Colombo, containing the following instruments, viz.:—

One standard barometer with a thermometer attached.
Do. do. thermometer.
Do. ordinary maximum thermometer.
Do. do. minimum do.
Do. maximum wet do.

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One minimum wet thermometer.
Do. solar radiation do.
Do. terrestrial radiation do.
Do. Ozone cage.
Do. rain-gauge.
Do. wind-vane.
Do. Robinson's small anemometer.
Do. Casella's enlarged self-registering anemometer.

All the above thermometers and barometer have been tested at either Kew or Greenwich Observatories, and all the instruments, which are issued from the head office to subordinate stations, are compared and the corrections noted.

The instruments at all the subordinate stations are similar to the instruments at Colombo, except the anemometers, which are non-registering, and the standard thermometer, which is not required.

The staff.

8. At the head office the staff consists of one paid observer at Rs.300 per mensem, and two other volunteers belonging to the Surveyor-General's department, under the superintendence of the Surveyor-General.

The salary of the observers at subordinate stations is Rs.10·00 a month, except Trincomalee, Rs.15·00.

Publications.

9. The following publications are issued at the Central Office:—

A monthly abstract of meteorological observations of all the stations.

An annual and average return of Rainfall, and the number of days in which rain fell.

Complete annual reports for 1881 and 1882, containing the averages for the last 14 years, are in the hands of the Government printer for publication.

The temperature in the monthly abstracts is the maximum and minimum observations, and the hygrometrical reductions are obtained by Glaisher's tables.

The temperature in the annual reports is the mean of the 9·30, 3·30 and minimum readings, and the hygrometrical reductions are obtained by the tables attached to the Indian Meteorologists Vade Mecum. The reason for this difference is caused by the annual reports for this island being prepared in connexion with the Annual Report on the Meteorology of India, published for the last seven years by the Indian Government.

Management and inspections.

10. The stations are inspected whenever possible by the Surveyor-General, or one of his assistants.

Historical.

12. Meteorological observations in Colombo were first systematically instituted by Colonel Fyers, R.E., Surveyor-General of Ceylon, in the year 1869, and gradually extended under his supervision throughout the island.

J. STODDART,
Acting Surveyor-General of Ceylon.

Surveyor-General's Office,
Colombo, March 10, 1883.

GREAT BRITAIN AND IRELAND. COLONIES. D.—NEW ZEALAND.

A reply has been received from Dr. J. Hector, F.R.S., Wellington, New Zealand. It does not contain much more information than the account of the Melbourne Conference. App. V., p. 20.

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ITALY.—ROME.

M. P. Tacchini, Central Meteorological Office, Rome.

Definition of system.

1. The meteorological service in Italy is distributed according to provinces, and as the provinces are 69 in number, as many observatories of the First Order * have been established; to these is entrusted the care of the observations which are made at all the other stations in the respective provinces. In this manner all the observations are collected by the observatories of the First Order, and are then forwarded to the Central Office.

Number and position of stations.

2. The number of stations of the First Order is 69, of the Second Order 37; those of the Third Order (at which only observations of rain and temperature are made) have reached the number of 400. Annexed is a list giving the geographical positions of the 69 stations of the First Order.

CENTRAL METEOROLOGICAL OFFICE, ROME.

Geographical positions of the Stations of the First Order.

No.	Stations.	Lat.	Long. from Rome.	—	Height above Sea.
		° ′	° ′		Feet.
1	Sondrio	46 10	2 35	W.	1191
2	Belluno	46 8	0 15	„	1325
3	Udine	46 4	0 44	E.	381
4	Como	45 48	3 22	W.	—
5	Bergamo	45 42	2 48	„	1254
6	Treviso	45 40	0 16	„	84
7	Vicenza	45 33	0 57	„	182
8	Brescia	45 32	2 16	„	564
9	Novara	45 30	3 54	„	551
10	Milan	45 28	3 18	„	483
11	Verona	45 26	1 28	„	217
12	Venice	45 26	0 9	„	69
13	Padua	45 24	0 39	„	101
14	Pavia	45 11	3 20	„	321
15	Mantua	45 10	1 42	„	131
16	Cremona	45 8	2 26	„	223
17	Turin	45 4	4 48	„	904
18	Rovigo	45 3	0 42	„	30
19	Piacenza	45 3	2 49	„	295
20	Alessandria	44 54	3 52	„	321
21	Ferrara	44 51	0 52	„	49
22	Parma	44 48	2 10	„	292
23	Reggio Emilia	44 42	1 51	„	202
24	Modena	44 39	1 33	„	211
25	Bologna	44 30	1 9	„	277
26	Ravenna	44 25	0 15	„	—
27	Genoa	44 24	3 34	„	178
28	Cuneo	44 23	4 57	„	1820
29	Forli	44 13	0 27	„	160
30	Massa	44 4	2 18	„	—
31	Pesaro	43 55	0 24	E.	45
32	Porto Maurizio	43 53	4 26	W.	206
33	Lucca	43 51	1 58	„	101
34	Florence	43 46	1 14	„	238
35	Pisa	43 44	2 5	„	33
36	Ancona	43 37	1 2	E.	99
37	Leghorn	43 33	2 11	W.	78

* These can hardly be termed stations of the First Order, as defined by the Vienna Congress, as the observations are only made three times a day.—ED.

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CENTRAL METEOROLOGICAL OFFICE, ROME.—*continued.*

No.	Stations.	Lat.	Long. from Rome.	—	Height above Sea.
		° ′	° ′		
38	Arezzo	43 27	0 36	W.	899
39	Siena	43 19	1 10	„	1143
40	Camerino (Macerata)	43 8	0 35	E.	2177
41	Perugia	43 7	0 6	W.	1706
42	Ascoli Piceno	42 54	1 6	E.	544
43	Grosseto	42 45	1 24	W.	103
44	Teramo	42 40	1 14	E.	938
45	Chieti	42 22	1 42	„	1118
46	Aquila	42 21	0 55	W.	2411
47	Rome	41 54	0 00	„	163
48	Agnone (Campobasso)	41 48	1 53	E.	2625
49	Foggia	41 27	3 2	„	287
50	Bari	41 9	4 22	„	—
51	Benevento	41 7	2 19	„	558
52	Caserta	41 3	1 53	„	250
53	Avellino	40 56	2 16	„	1214
54	Naples	40 52	1 46	„	489
55	Salerno	40 42	2 16	„	172
56	Sassari	40 40	3 19	W.	704
57	Potenza	40 39	3 19	E.	2717
58	Lecce	40 22	5 43	„	236
59	Cosenza	39 19	3 48	„	839
60	Cagliari	39 13	3 23	W.	115
61	Cantanzaro	38 55	4 18	E.	1066
62	Messina	38 12	3 4	„	87
63	Reggio Calabria	38 8	3 10	„	59
64	Palermo	38 7	0 52	„	237
65	Trapani	38 3	0 3	„	88
66	Catania	37 30	2 34	„	102
67	Caltanissetta	37 20	1 33	„	1871
68	Girgenti	37 16	0 54	„	837
69	Syracuse	37 3	2 46	„	71

Organization of stations.

3. At the stations of the First and Second Order the hours of observations, are 9h. a.m., 3h. and 9h. p.m., and the observations include barometer, thermometer, humidity, evaporation, direction, and force of wind, rain, state of the sky, and of the sea.

Most of the directors of stations of the First Order are professors of physics at the Government educational institutions, who, like the others, follow the printed and written instructions which are furnished to them by the Central Office; the same may be said of the tables of reduction, which are partly those published in the "Annuaires Météorologiques" of France and partly those edited by Mr. A. Guyot, entitled "Tables Meteorological and Physical," Washington, 1859. Some of these tables however have been notably amplified and modified.

The checking of the observations is carried out by means of proper inspections, on which occasions also the instruments are compared with the inspector's standards which are taken with him. Every station of the First and Second Order is, on an average, inspected every two years.

Special observations.

4. A special service for the observations of thunderstorms is organised in every province. This is done by means of cards (like post cards) a specimen of which is annexed, and which are distributed in every province by the directors of the observatories, who after having collected them, duly filled up, forward them to the Central Office.

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(Copy of Post Cards).

Address { Thunderstorm Service.
To the Meteorological Observatory
of.....

Particulars { Province.....
Station.....
Thunderstorms.
Day month year.
Began at hours minutes.
Ended at „ „
Direction of the storm.
Winds.
Did the thunderstorm occupy all the visible sky ?
Rain. Hail.

Notes.

In 1882 the Central Office received 7,767 cards, distributed as follows :

Upper Italy	31 provinces	5,418 cards.
Central Italy	16 „	919 „
Lower Italy	22 „	1,430 „

To this number of 7,767 cards must be added all the other observations of thunderstorms recorded in the forms of meteorological observations, made at Stations of the First and Second Order, so that altogether we may reckon that for the year 1882 the number of observations reached 9,000.

The service of phenological observations was not organised in 1882.

Marine observations.

5. Maritime observations are made by some harbour masters and at some semaphore stations.

Weather telegraphy.

6. For the daily telegraphic service, the Central Office receives every day meteorological telegrams from the following stations :

From Italy	44	in number.
„ Russia	6	„
„ Austro-Hungary	10	„
„ Bavaria	4	„
„ France	5	„
„ Algeria	4	„
„ Switzerland	4	„
„ Iberian-Peninsula	4	„
„ Malta	1	„
„ Constantinople	1	„
„ London	1	„
Total	84	

The Central Office of Rome sends every morning by telegraph the observations from nine Italian stations and those from Malta to the central offices of St. Petersburg, Vienna, Munich, Zürich, Paris, Trieste, Madrid, and Constantinople.

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After the construction of the meteorological chart for the day, the daily meteorological telegram is compiled from the observations collected, and is generally sent a little after 2h. p.m. to 37 stations, including observatories and harbour masters, and to 34 semaphores.

Special telegrams are also sent to the semaphores at any hour according to need, and are also requested in special conditions of weather. After reduction and study of the data, the meteorological bulletin, on four pages, is published every day, containing isobars for Europe for every five millimetres, and further details separately for Italy. This bulletin was, and is, sent the same day to all correspondents.

The Central Office.

7. The Central Office is the only one in the Kingdom, and is situated at Rome, at the Collegio Romano, and is attached to the observatory of the same college.

All the instruments are compared with the standards at the Central Office, and are afterwards distributed to the stations. Some of these instruments, such as anemometers, anemoscopes, evaporators, meteorographs, hygrometers, &c., are constructed in the workshop annexed to the Central Office itself, under the superintendence of MM. Brassart Brothers.

The staff.

8. The *employés* of the system are paid from the funds allotted in the accounts of the State, of the provinces, of municipalities, and of some corporate bodies, such as Academies, &c., as well as from some private sources. The Central Office grants only subsidies and allowances, which amount to 400*l.* a year.

Publications.

9. The Central Office publishes the following:—

Annalia della meteorologia italiana.
Bullettino mensile internazionale.
Bullettino meteorico agrario decadico.
Bullettino meteorico giornaliero.
Rivista meteorologica mensile.

And also readily publishes any original meteorological memoirs which are communicated to it by the directors of Italian observatories. It sends also every month the simultaneous observations requested by the Washington Office.

The following stations:—Turin, Moncalieri, Milan, Genoa, Vicenza, Venice, Pesaro, Ancona, Foggia, Lecce, Naples, Salerno, Palermo, Syracuse, Potenza, Porto Maurizio, and Lucca publish special bulletins and meteorological annals.

Management and inspections.

10. Mention has been made under point 3 of the inspection of the observatories; every observatory has its own administration, dependent upon the corporate body to which it belongs. The expenses for the purchase of instruments are almost all borne by the Central Office, which is under the Ministry of Agriculture, Industry and Commerce.

Supplementary remarks.

11. The applications for the establishment of new stations, for obtaining instruments, or grants of money must be made to the Central Office, which submits them for the approval of the Superintending Council, who hold their meetings at the same office.

Historical.

12. With respect to the historical *résumé* of the meteorological service in Italy, see the introduction to vols. I. and II. (Part I.) of the Annals for the years 1879 and 1880.

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ITALY.—NAPLES.

M. A. de Gasparis, Royal Astronomical Observatory, Naples.

As Director I reply to your circular. The observatory of Naples, at Capodimonte, was at its origin destined for astronomical observations. If the institution has rendered some service to Meteorology, it has been owing to the appointment of Professor Brioschi to this important branch of research and his singular aptitude for it.

Professor Brioschi has published, with my assistance, during the space of upwards of 18 years a valuable series of meteorological observations, which, having been made by him with the greatest care, are sufficient for the determination of local means. Besides the barograph and thermograph observations obtained every 15 minutes for all the 24 hours, and published for each hour without interruption for more than 12 years, they will furnish data for important researches.

Professor Brioschi, who has indefatigable activity and zeal, is the *only* person who is occupied with Meteorology in the observatory. All the other *employés* are entirely occupied with astronomical duties. It is clear therefore that the observatory of Naples cannot be a meteorological station taking part in the observations which are required. In fact, it would be necessary to appoint quite a staff of observers for meteorology, which certainly cannot be done at the Naples Observatory, although it is seen that at Paris, Vienna, Berlin, and St. Petersburg the astronomical observatories are separate and rendered independent of the meteorological observatories, because the latter have developed greatly. and have required great expenditure.

Professor Brioschi has hitherto worked enough for Meteorology. The observatory wishes to utilize his valuable services as an observer in getting him to carry on magnetic observations with greater completeness. The two Gauss's magnetometers readjusted by him, Barrow's dip instrument already purchased and at work, and the declinometer already ordered in London, will give Professor Brioschi sufficient occupation for himself and two astronomical assistants.

I wish that this reply should have some publicity, so that any doubt may be removed.

THE NETHERLANDS.

Professor Buys Ballot, Royal Meteorological Institute, Utrecht.

1. The Dutch meteorological system has aimed from the beginning at combining reliable observations over the world with each other, and thus showing the disturbances of the atmosphere and their mode of propagation, and at obtaining from the logs of merchant vessels statistical results as to the best routes. Definition of system.

2. Two stations of the First Order, Utrecht, lat. 52° N. long. 0° 11′ E., and Helder, lat. 52° 56′ N., long. 4° 45′ E.; five of the Second Order, Groningen, Leeuwarden, Flushing, Maastricht, Hellevoetsluis; and four of the Third Order, Amsterdam, Assen, Delfzyl, Tilburg. Number and position of stations.

3. There is nothing particular to be said about the organization. The hours of observation are 8 a.m., 2 and 8 or 10 p.m. The tables of reduction are Guyot's. A check is continually made by comparisons, it being a very severe test that every month in the "Afwykingen" the observations of every station are placed next to those of the other stations. As soon as a doubtful observation has been detected, inquiry is made, and an inspection follows. Organization of stations.

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Special observations.

4. We have 50 rain stations, which also record hail, snow, wind (force and direction), with the exact time of beginning and ending. Also a large number of thunderstorm observers, who in some cases exceed 300. Forms are distributed all over the country containing a number of definite questions, the answers to which are all that is required, and the forms are sent through the post, free of charge.

Marine observations.

5. At sea the usual observations are recorded. The men-of-war take them in full; we have only asked those merchant captains to observe who are likely to send observations which will be of practical use. The observations required are the ship's position at noon, the dead reckoning, direction of currents, barometer, wind, temperature of the seawater, and cloud.

Weather telegraphy.

6. Telegrams are received three times a day; at 8 o'clock a.m. from 26 foreign places; at 12.30 and 7 p.m. from the four stations at the extreme points of the kingdom.

Intelligence is sent every morning and again in the evening to the ports. The warning notices are telegraphed in three groups of five figures, some of which have a conventional signification known to the receivers. These telegrams are sent to the newspapers and to the ports. At the latter the telegrams are converted and publicly exhibited.

The Central Office.

7. The Central Office is at Utrecht; there is a subordinate marine section at Amsterdam under Mr. van Hasselt, which has been established more particularly for the benefit of the seafaring community; and one at the Helder, where an observer has care of all the registering instruments. Instruments are supplied from Utrecht.

The staff.

8. The staff is composed of Dr. Snellen, Baron van Heerdt, and Mr. van Hasselt, who receive a salary of 200*l.* each. Observers and clerks have a salary of 42*l.* to 100*l.* The observers are volunteers, directors of middle-class schools, &c. The only person who receives anything like a salary, say 63*l.*, is M. Zaatman at Helder.

Publications.

9. Publications are only issued from Utrecht and Amsterdam.

Management and inspection.

10. As already stated, in this small country inspections of the stations are seldom made, except when the continual check kept upon the observations shows that they are wanted.

Historical.

12. It is only necessary to compare the different volumes of the Jaarboek to see how the publications fulfil the principal requirements more and more each year.

In the first place Part II. of the volume gives the normal values of pressure, temperature, rain, for many places in the northern hemisphere. In Part I. the climatology of the Netherlands is attended to.

The publications of the marine section show the best tracks of ships for the routes followed by Dutch ships, and also contain barometer heights and wind (direction and force), storms, thunderstorms, and rain in the Atlantic and Indian Oceans.

Telegraphic warnings were proposed in 1857 and adopted and issued on the 1st of June 1860.

NORWAY.

Professor H. Mohn, Norwegian Meteorological Institute, Christiania.

Definition of the system.

1. The Norwegian Meteorological Institute.

Number and positions of stations.

2. First Order, 1 (Christiania), Lat. 59° 55′ N., Long. 10° 43′ E.
„ „ Second Order 33.
„ „ Third „ 15.

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3. *Outfit of the Station of First Order.*—A barograph by Höttinger, a thermograph by Rung, a standard barometer by Negretti and Zambra, Wild's thermometer screen, dry and wet bulb thermometers, minimum and maximum thermometers, Wild's wind-pressure plate, Robinson's cup and dial and anemometer, modified by Mohn, a rain and snow gauge. Organisation of stations.

Outfit of Stations of Second Order.—A Kew Barometer (at two stations a Fortin's barometer); dry and wet bulb thermometers (thermometers by Aderman, metal screen); a minimum thermometer (*see* "Grundzüge der Meteorologie," third edition, page 93); a spare thermometer; Wild's wind-pressure plate (stations; a rain gauge and snow gauge (*see* "Grundzüge der Meteorologie," 3rd edition, page 187); an aneroid barometer as a check instrument.

Outfit of Stations of the Third Order:—

(*a.*) *Lighthouse Stations.*—Thermometers in a cylindrical zinc screen, minimum thermometer screened, aneroid barometer, water thermometer, Wild's wind-pressure plate, spare thermometer.

(*b.*) *Climatological Stations.*—Ordinary thermometers and minimum thermometer, with screen same as (*a.*). (Some have dry and wet bulb thermometers.) Rain and snow gauges. The wind is observed without an instrument.

Hours of Observation.—Generally 8 p.m., 2 p.m., and 8 p.m. Instructions printed in Norwegian; drawn up according to the decisions of the Meteorological Congresses and of the International Committee. Guyot's tables for barometer, Jelinek's for dry and wet thermometers.

Checking of the Observations.—All the observations are revised and reduced at the Meteorological Institute. The barometer observations are checked in the following way (*see* "Jahrbuch" of the Norwegian Meteorological Institute for 1876, p. ix.):—All the barometer observations of each station are plotted upon millimeter (sectional) paper. The horizontal scale is 10mm. for a day, the vertical scale corresponds to the actual extent of the barometer readings. A curve is drawn with a free hand through the points which have been laid down. The curves for a series of stations are drawn underneath each other on the same sheet, so that each station always lies between its two adjacent stations. A glance at the curves exhibit at once the jumps in the series of observations, and show that the observers have made mistakes of 5 mm., 10 mm., 15 mm., 20 mm., and so on. Such obvious errors are corrected in the tables. It is also easy to judge from the agreement between the curves of adjacent stations whether the observations of individual stations are generally trustworthy or not.

Synoptic charts for the whole of Norway are drawn every day from the morning observations, showing the barometer readings, wind, and weather for all stations. The morning observations from Sweden and Denmark which are contained in the "Bulletin du Nord" are also inserted, and sometimes those of the "Daily Weather Report," and some from the "Wetterbericht der Deutschen Seewarte," and the "Russische Bulletin." The isobars are drawn, and accordingly the readings of all our barometers are mutually checked.

General synoptic charts for Norway are drawn each month, containing monthly means of barometer (reduced to sea-level), air temperature and wind force, prevalent wind-direction, and the amount of rainfall. The natural course of the isobaric lines checks the barometer corrections. The accuracy of the absolute amount of the corrections is ensured for most stations by verifications and inspections. How well the Kew barometers maintain their corrections may be seen from the

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introduction to the last volumes of the "Jahrbuch" of the Norwegian Meteorological Institute.

The minimum thermometers are checked every day by comparison with the dry-bulb thermometers.

Special observations.

4. Thunderstorms are observed by about 50 special observers, in addition to those at the stations above mentioned. Phenological observations are not made in connexion with the Institute.

Marine observations.

5. The Institute receives about 20 logs yearly. The registers and printed instructions for taking the observations are issued by the Institute, and some instruments are verified there. The observations include barometer, air temperature, sea-surface temperature, wind direction and force, amount of cloud, rainfall, &c. and sea disturbance.

Weather telegraphy.

6. By the assistance of the Telegraphic Administration the morning observations from Bodö, Christiansund, Florö, Skudesnes, Oxö, Sandosund, and Dovre are posted up for public use at all Norwegian ports, which are connected by telegraph at about 10h. a.m.

The Meteorological Institute receives, in addition to these morning observations, evening observations from Bodö, Christiansund, Skudesnes, and Oxö, and morning observations according to the International Code, from Haparanda, Hernösand, Stockholm, and Wisby; from Copenhagen and Fanö; from Dunrossness, Aberdeen, Yarmouth, and Valencia, and also wind and weather observations for the morning hour from Egersund, Ystad, Helsingborg, and Skagen. After receipt of these communications the observations are entered on a chart at noon, isobars are drawn, and the change of pressure since the previous evening is calculated. As soon as a sufficient idea of the situation is arrived at, this, as well as the forecasts for the next day, are made known by publicly posting them up with the weather charts and reports for morning and evening, and the bulletin is communicated to the Christiania newspapers.

The Christiania "Morgenblad" publishes a chart printed from the manuscript of the Institute by Rung's method; the same is also published by the "Bergenspost" at Bergen. If a storm is expected warnings are immediately issued to all places threatened, giving the direction from which the storm will probably blow. This warning is at once forwarded by the telegraph office, and its contents communicated to the harbour authorities, principal pilots, and heads of fisheries, to distribute them further if necessary. Storm warnings are issued from Christiania practically only for the South of Norway. The French telegrams do not arrive before mid-day. The afternoon telegrams from Skudesnes and Aberdeen are also used for storm warnings.

An attempt was made last summer, as an experiment, to warn agriculturists in Smaaldeneue (east of the Christianiafjord) during harvest time; 81 % of the warnings were successful, 9 % partially successful, and 10 % were failures.

The Central Office.

7. The Central Office of the System is at Christiana. The Meteorological Institute belongs to the University. The director is Professor of Meteorology at the University. The first assistant is appointed by the Senatus of the Academy, the others by the Director of the institute. The funds for the institute proposed by the Director to the Senatus and the Government are voted by the *Storthing*. The institute rents an office in the town. The daily observations are made in the park of the Astronomical Observatory by the staff of the institute. In addition to the instruments mentioned under (3), the institute possesses a collection of spare instruments, apparatus for testing barometers and thermometers, deep-sea thermometers, diagrams for lectures, &c.

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8. The staff consists of—the director (professor at the University), salary 330*l.*; first assistant, 132*l.*; second assistant, 199*l.*; third assistant, 88*l.*; fourth assistant, 88*l.*; and caretaker, 26*l.* 8*s.* The staff.

Of the observers at the stations 21 receive a yearly remuneration of 7*l.* 18*s.*

9. The annual publications of the Meteorological Institute are :— Publications.

1. Year-book of the Norwegian Meteorological Institute.

2. Meteorological summary for each month, published in the "Agricultural Journal."

3. Summary of the weather in Norway for each year in the same journal.

10. The management is under the University and the director. The stations are inspected often, say every third year, by the director or one of the assistants. This frequency of inspection is found quite sufficient, with the Kew barometers now used and the improved Instructions. Management and inspections.

11. The amount of the annual grant is now 453*l.*, exclusive of the salary of the staff, but including the rent of the institute. Supplementary remarks.

12. The Norwegian Meteorological Institute was established in 1866, and commenced work on the 1st December 1866, after I had made a journey abroad and a tour of inspection to the five stations established in 1860 in Southern Norway, by M. C. Nielsen, Director of Telegraphs. In the following years a number of new stations were established both in Northern and Southern Norway. After the Meteorological Congress at Vienna in 1873 the stations were, by a munificent vote of the *Storthing*, provided with new barometers, thermometer screens, wind-gauges, and rain-gauges. In 1870 the institute published a Storm Atlas. Summaries of the climate of Norway have often been given. Now the whole series of observations from 1861 are being used, after thorough revision, for a more accurate representation of the climate of Norway. The yearly reports of the director to the Senatus of the Christiania Academy, printed in Norwegian, will best show the development of the Institute. Historical.

PORTUGAL.

Captain J. C. De Brito-Capello, Observatory of the Infante D. Luiz, Lisbon.

1. The meteorological system of Portugal comprises the central observatory of the Infante D. Luiz and its network of stations of the First, Second, and Third order, on the mainland, in the Azores and Madeira, and in the territories in Africa and Asia. Definition system.

There is also, independently of the system, a meteorological and magnetical observatory at Coimbra belonging to that University.

The observatory of the *Infante* D. Luiz is at the same time an observatory of the First Order, and a meteorological office, with a system of subordinate meteorological stations.

2. Our stations are arranged in the following way: Number and positions of stations.

Two stations of the First Order :—

——	Lat.	Long.	Height above Sea.
	° ′	° ′	Feet.
Sierra da Estrella - - - - - -	40 23 N.	7 35 W.	4,728
Loanda - - - - - - - -	8 49 S.	13 7 E.	194

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Ten stations of the Second Order:—

——	Lat.	Long.	Height above Sea.
	° ′	° ′	Feet.
Montalegre	41 49 N.	7 45 W.	3,281
Nizen	40 39 „	7 57 „	1,949
Guarda	40 32 „	7 14 „	3,409
Campo-maior	39 2 „	6 59 „	945
Angra do Heroismo (Azores)	38 39 „	27 14 „	144
Ponta Delgada (Azores)	37 45 „	25 41 „	66
Funchal, Madeira	32 38 „	16 55 „	82
St. Thomas (Id.)	0 20 „	6 43 E.	16
Macao (China)	22 10 „	113 32 „	46
Goa (Hindostan)	15 28 „	73 55 „	23

Five stations of the Third Order:—

——	Lat.	Long.	Height above Sea.
	° ′	° ′	Feet.
Moncorvo	41 10 N.	7 1 W.	1,383
Oporto*	41 9 „	8 35 „	328
Cintra	38 50 „	9 21 „	502
Evora	38 35 „	7 52 „	1,027
Lagos	37 6 „	8 38 „	43

Organization of stations.

We have only on the mainland of Europe one station of the First Order, Sierra da Estrella, which has been quite recently established.

The staff is composed of two observers, one of whom has the management, and of a servant.

The station is provided with ordinary and self-registering instruments for the principal meteorological elements.

The hours of observation are 7h. a.m., 9h. a.m., 11h. 30m. a.m. (Washington simultaneous observation), noon, 1h. p.m., 3h. p.m., and 9h. p.m.

The other station of the First Order is at Loanda; it is managed by a marine officer (harbour-master) assisted by an officer and a petty officer. The hours of observation are 9h. a.m., 11h. a.m. (Washington simultaneous observation), noon, 3h. p.m., and 9h. p.m.

This station, or rather this observatory, is in a special building, at which astronomical observations are made in order to give the exact time to the vessels anchored in the harbour. In addition to the meteorological observations, observations of magnetic declination, dip, and horizontal force are made.

The salaries of the observers are borne by the government of the province.

The stations of the Second and Third Order, although the majority are situated in various establishments, and are under the superintendence of the directors, viz., professors of secondary schools, directors of public works, physicians, &c., yet their assistant-observers follow a common plan, in accordance with the Instructions furnished by this Institution. The appointment of the assistant observers is made by the director of this central observatory, on the nomination of the directors of the stations. The salaries are paid from the vote of this central observatory.

The hours of observation at the stations of the Second Order are generally† 9h. a.m., noon, 3h., and 9h. p.m.

* The construction of a meteorological and magnetical observatory at Oporto has been begun.

† At Montalègre and Guarda the 9h. p.m. observations are omitted, and at S. Thomas the noon observations are omitted.

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In addition to these hours, the international stations, Campo-Maior, Angra, Ponta-Delgada, and Funchal take simultaneous observations at 7h. a.m., Washington time.

The hours of observation at stations of the Third Order are 9h. a.m. and 3h. p.m.

The Instructions furnished to the observers at stations of all orders are the same as in use at this central observatory, and in accordance with the decisions of the recent congresses of Vienna and Rome.

The tables for the reduction of barometer readings to 32° F. are those of T. Haeghens. For relative humidity and tension of vapour we employ the hygrometric tables by the same author, printed by the Smithsonian Institution.

The observations are checked at the central observatory by one of the heads of the service, who has charge of the service of the stations, aided by assistants. The registers of the different stations are compared in order to detect the most frequent errors.

All the values of humidity and vapour-tension are re-calculated.

The tables of published monthly observations are arranged and the means calculated at the central observatory.

Special observations.

4. Observations of thunderstorms, hail, &c., are made by the directors of telegraph stations, forest employés, directors of public works, &c. The observations are made on a regular form supplied by this observatory and are quite optional.

We cannot at present state exactly the number of these stations or of the observers. These observations are also of very recent date, having been commenced in October 1882.

We have not yet begun phenological observations.

Marine observations.

5. Meteorological observations at sea are now taken almost on ships of war only. An officer on board is charged with the observations, and is assisted by the cadets. The hours are those adopted at the Maritime Conference at London (1874): 0h., 4h., 8h., 16h. astronomical time.

The instructions are drawn up in accordance with the decisions of the same conference. The instruments are supplied by the Hydrographic Office of the Ministry of Marine, but they are compared with the standards of this observatory.

In addition to these observations, at 7h. a.m., Washington time, are made, principally when the vessels are in port.

The instruments are the following :—

Barometer by Adie.
Aneroid.
3 Thermometers by Casella or Negretti and Zambra.
3 Glass hydrometers do. do. do.

Weather telegraphy.

6. Thirteen stations from this country, three from Spain (Corunna, San Fernando, and Madrid), and nine from France (total 25) send morning telegrams to this observatory. The observations at the stations of this country (continental) are made at 7h. a.m. in summer and at 8h. a.m. in winter.

The telegrams from France, Spain, Funchal, and Sierra da Estrella are composed of groups of five figures, in accordance with the instructions of the Vienna Congress; those from the other stations in this country send telegrams according to the old code.

Generally, during fine weather, the telegrams from the peninsula and from Funchal are received between 11h. a.m. and noon, and those from France before 1h. p.m.

In bad weather, just when the telegrams are most necessary, their arrival is much delayed, and very often a large part of them do not

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arrive at all, especially those from France and the more elevated stations of this country.

In favourable circumstances the study of the telegrams, the drawing of the isobars, the forecast of the weather for the following day, and lastly, all the report is written upon transfer paper and sent to the lithographer between 1h. 15m. and 1h. 30m. p.m. The bulletin is issued between 2h. 45m. and 3h. p.m.

During bad weather the bulletin, which is then generally incomplete, is issued about 4h. p.m.

The report contains observations from 16 stations, 14 from this country, including Lisbon and Coimbra, and two from Spain.

The isobars are drawn on a small chart, together with small arrows, indicating the direction and force of wind.

The telegrams are all sent free.

The bulletins are supplied to all the Government offices and to public and private maritime offices and establishments frequented by the public.

When, after a study of the telegrams, it is found to be requisite, telegrams are sent to the semaphoric stations ordering the hoisting of storm-warning signals. The signals are a "cone" and "drum," the same as used in England,* with similar instructions.

The Central Office.

7. The following are the principal instruments of this observatory :—

Pressure :

2 Standard barometers, one of which is a siphon by Lerebours and Secretan, of Paris, 1854, tube 18·5 mm., and reading to 0·01 mm.

Standard cistern barometer, tube 32 mm., reading with cathetometer to $\frac{1}{20}$ mm.

Barograph on the photographic system, by Salleron, of Paris, 1863.

A Redier's barograph, 1878.

Temperature :

Standard thermometer, presented by the Kew Committee, 1853.

Thermograph, on the photographic system, by Salleron, of Paris, 1863.

A Redier's thermograph, 1880.

Direction and force of wind :

An Osler's anemometer modified, with Robinson's cups for direction, and a small Cator's anemometer for wind-force.

A portable anemometer, giving the direction and velocity, by Casella, 1879.

Instruments for daily readings :

Barometer by Adie, tube 10 mm.

Dry and wet bulb thermometers, Adie, 1857.

Do. do. do. Negretti and Zambra.

Actinometer, Marié-Davy and Negretti and Zambra.

Solar and terrestrial radiation thermometers, Negretti and Zambra.

Self-recording rain gauge, "udomètre," by Babinet.

Self-recording rain gauge connected to the anemographe.

Evaporator, with diameter of 252 mm.

Ditto, by Piche.

Electrical thermometers on Becquerel's principle for depths of 10 metres and 5 metres.

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* The drum is not now used in England.

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Thermometers on Lamont's system for depths of 1·5, 1·1, 0·7, 0·7, 0·3, and 0·05 metres.

Terrestial Magnetism.—Magnetometer, for the determination of the horizontal force and declination, by Elliott Brothers, on the metric system.

Dip circle, by Dover.

Magnetographs on the photographic system, by Adie, 1862.

Atmospheric Electricity.—Photographic electrograph, by Branly.

Thomson's portable electrometer.

The instruments of the two sections of the First Order, Sierra da Estrella and Loanda, are the following:—

Barometer, by Adie, metric scale.

Dry and wet bulb thermometers, by Negretti and Zambra.

Maximum and minimum thermometers, by „

Anemometer, by Casella, in kilometres.

Portable anemometer, by Casella.

Barograph, by Richard.

Thermograph „

Rain gauge, by Babinet.

Ordinary zinc evaporator and one by Piche.

Marié-Davy's actinometer (except at Loanda).

Solar and terrestrial radiation thermometers, by Negrettiand Zambra.

In addition to the above instruments, the station at Loanda possesses magnetical instruments for the determination of horizontal force (Johnson's magnetometer), declinometer by the same maker, and dip circle by Dover.

The instruments at the stations of the Second and Third Order, are the following:—

Barometer, by Adie.

Aneroid.

Dry and wet bulb thermometers, by Negretti and Zambra.

Maximum and minumum „ „

Anemometer, by Casella.

Self-recording rain gauge, Babinet.

Zinc evaporator, with diameter of 252 mm.

8. The station of Sierra da Estrella has two observers, one of whom has the superintendence; there is also a servant; total three employés: The staff.

	£
The salary of the superintendent is -	120
That of the second - - -	88
The servant - - - -	44
For the expense of the forage of a horse, for attendance, fire, lights, and incidental expenses - - - -	53

The other station of the First Order, Loanda, is under the superintendence of a naval officer, harbour-master, assisted by another officer, and sub-officers.

The salaries for these special services are borne by the Government of the province.

At the stations of the Second and Third Order the directors are professors, doctors, and engineers of public works; they receive no salaries.

The observers are paid 24*l.* a year.

At the four "international" stations, at which observations are made five times a day (including the simultaneous observation for Washington), there is a second assistant with a salary of 20*l.*

At Funchal, a special remuneration of 5*l* a year is added for the 7h. a.m. observation.

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Publications.

9. The regular publications of this Institute are:

Annales do Observatorio do Infante D. Luiz, containing the various observations made at the observatory and those of the stations "*Postos meteorologicos*."

In addition there are the publications of the observations of terrestrial magnetism, and researches on various branches of meteorology.

There are no independent publications of the stations.

The Meteorological and Magnetical Observatory of Coimbra publishes meteorological and magnetical observations.

Management and inspection.

10. The management and inspection of the stations are carried out by this Central Institute.

The observers and subordinate employés are appointed by this observatory, on the nomination of the directors of the stations, subject to the approval of the Government.

The payment of the salaries of the observers and all attendant expenses of the system are fixed according to schedules of expenses approved by the Government from funds voted in the estimates of the Ministry of the Interior.

The inspection of the stations is done by the chief of the service of this observatory, although it is not done so regularly as might be desirable.

The instruments are supplied by this central observatory. There is a fixed sum provided in the estimates for the purchase of instruments.

Supplementary remarks.

11. The general vote for meteorology is at present the following:

Observatory of the Infante D. Luiz.

		£
Salaries	Director (honorarium)	88
	Observers (3)	400
	Assistants (3)	240
	Photographer	32
	Servant	32
		£792

		£
Materials	Gas	53
		52
	Instruments	109
	Chemicals	25
	Printing (annals and bulletins)	309
	Incidental expenses	53
		£601

Meteorological Stations.

	£
Sierra da Estrella	308
Ten observers	240
Four assistants	84
	£632

Total expense	£2,025

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12. The observatory of the Infante D. Luiz was established in 1854, but was only in 1863 installed in a building expressly erected at the Polytechnic School. Historical.

The station at Oporto was established in 1861, and two years later those of Guarda and Campo Maior.

In 1864 almost all the existing stations were established, and in 1865 Parliament voted in the estimates of the Ministry of the Interior funds for the outfit and maintenance of 10 stations.

The year 1865 may be quoted as the date of the regular foundation of the system, subordinate to this observatory as a central institute.

The two stations of the First Order are of more recent creation. The station of Loanda was only completed in October 1878. The station of Sierra da Estrella was established more recently; it has only been in operation since January 1882.

The Coimbra Observatory is not included in the system, but it was founded in 1864.

RUSSIA.

Dr. H. Wild, Central Physical Observatory, St. Petersburg.

1. The system of meteorological stations under the Central Observatory embraces the whole of the Russian Empire, except the Grand Duchy of Finland, which possesses a Central Observatory of its own at Helsingfors. The magnetical and meteorological observatory connected with the missionary establishment in Pekin is also under the Central Physical Observatory. Definition of system.

2. The following meteorological stations belong to this meteorological service :— Number and positions of stations.

(*a.*) Two stations of the First Order, viz. :—

Pawlowsk	-	Lat. 59° 41′,	long. 30° 29′,	height 133 feet.
Tiflis	-	„ 41° 43′,	„ 44° 47′,	„ 1343 „

at which complete hourly magnetical and meteorological observations are made (either direct or by help of self-registering instruments); and six stations, intermediate between those of the First and Second Order, viz., A, the magnetical and meteorological observations at Pekin, Catharinenburg, Barnaul, Moscow, and Nertschinsk, where, in addition to the ordinary observations made at stations of the Second Order, special observations (evaporation, earth temperature, radiation, &c.) and magnetical determinations at certain hours are made, and B, the observatory at St. Petersburg itself, where more extensive meteorological observations are taken.

(*b.*) 132 stations of the Second Order. The observations are taken three times a day, and include air-pressure, temperature, humidity, direction and force of wind, cloud, rainfall, and remarks; a number of these stations also make observations of earth temperature and evaporation.

(*c.*) 44 stations of the Third Order (viz., stations at which one or more of the elements mentioned for stations of the Second Order are not observed). In this category we have included the 17 lighthouse stations of the Baltic Sea, at which, for want of sufficient instruments, we have only been able to make use of the wind observations.

3. The complete meteorological stations generally possess the following instruments: a zinc screen, with dry and wet thermometer, hair-hygrometer, and minimum thermometer; a rain gauge and measuring glass, a Organization of stations.

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small wind vane, with swinging plate for measuring the force, siphon barometer in metal frame, and an aneroid. The corrections of the instruments are determined at the Central Observatory, and the corrections are supplied to the observers. The hours of observation at stations of the Second and Third Order are generally 7h a.m., 1h., and 9h. p.m. At all the regular stations observations are made according to the "Instructions " for Meteorological Stations," by H. Wild (in the "*Repertorium für Meteorologie*," Vol. V., No. 1). The observations are reduced by M. Wild's "*Tafeln für Berechnung der meteorologischen Beobachtungen*," which are issued as a Supplement to the Instructions for meteorological stations.

The meteorological observations sent to the central observatory are generally checked by the staff of the observatory who attend to this work, by comparison with the data of synoptic charts, and with the observations of neighbouring stations, and the accuracy of the reductions is examined; finally, the means of the verified tables are extracted for publication. The Caucasian stations, under the superintendence of the Tiflis Observatory, send their observations to that observatory, and the latter, after they are checked, sends them to the central observatory ready for printing. The observations of the Caucasian stations, and those of the Pekin Observatory, are not subjected to any further check at the central observatory.

Special observations.

4. The stations at which only observations of rainfall, thunderstorms, and hail are made have been hitherto under the Geographical Society, but the number of such stations is small (about 40). Phenological observations are made at some places, but are not taken on any regular plan, and can therefore only be considered as casual observations.

Marine observations.

5. The Assistant of the Director of the Central Observatory, M. Rikatschew, has drawn up instructions for observations to be made by the Russian Navy in accordance with the decisions of the London Conference; these have only been introduced provisionally. The ships draw their instruments from the Hydrographic Department, to which they also send their logs; the Hydrographic Department transfers the logs to the maritime branch of the Central Observatory for examination and subsequent publication.

Weather telegraphy.

6. In the weather branch of the Central Observatory daily telegrams are received from 66 Russian (including 8 in Finland) and 54 foreign meteorological stations. These telegrams, which are composed of figures according to the International Code, mostly contain the observations of the previous evening, besides the morning observations of the day in question. After the telegrams have been converted, and the data reduced and entered in the registers, they are used in the ordinary way for the construction of synoptic charts. In addition to synoptic charts other charts are drawn showing the change in the weather from one day to another. Upon the basis of the data contained in these charts weather forecasts are prepared, and in the event of an impending storm the places affected are warned. At present regular storm warnings are restricted to the Ports of the Baltic, and some of the larger inland lakes (Onega, Ladoga, and Ilmen). A note is made of each storm warning, and the success is checked from the weather of the same and the following day.

The Central Office.

7. The Central Physical Observatory is a Government Institution under the Imperial Academy of Sciences, and like the latter belongs to the Ministry of Public Instruction. According to the various duties of the observatory, the following division of work is made among the different departments of the institution.

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(*a.*) The Meteorological Observatory of St. Petersburg, in addition to the regular meteorological observations, undertakes the verification of instruments for the meteorological stations. One physicist and two observers are occupied in carrying out these duties.

(*b.*) The reduction, checking and printing of the observations from land stations are entrusted to a special department; this branch is directly under a physicist, aided by two computers.

(*c.*) The department for Ocean Meteorology consists of one physicist and two adjuncts. These have to undertake the reduction and checking of the observations made at maritime stations, lighthouses and on ships.

(*d.*) The weather department prepares the weather reports and synoptic charts and looks after the issue of storm-warnings. This work is done by a physicist and two adjuncts.

The Departments *c* and *d* are under the special supervision of the Assistant of the Director.

(*e.*) The mechanical workshop of the Observatory has to look after the construction of new and the repair of damaged instruments, and the furnishing and forwarding of instruments to the newly established meteorological stations. The mechanician of the Observatory carries out these duties with the help of one assistant.

In matters relating to administration the director has the assistance of a scientific secretary, and the necessary number of clerks; a steward is appointed for the superintendence of the buildings, including attendance to the Observatory.

Among the stock of the instruments of the observatory there are the necessary standard instruments for verifications; one or more self-registering instruments for each of the most important meteorological elements (air-pressure, temperature and humidity of the air, direction and force of wind and rainfall), as well as a gauge (Limnigraph) for registering the height of water in the Neva. In addition to the instruments for an ordinary station of the Second Order there are instruments in use for the determination of evaporation, of earth-temperature at various depths and of radiation.

The magnetical and meteorological observatory at Pawlowsk must be considered as a special department of the Central Institution under the superintendence of the director of the central observatory both as regards its administrative and scientific relations. The immediate supervision of the work in this observatory is deputed to a manager, with the assistance of a physicist and three observers. In addition a mechanician and a steward are attached to the Observatory.

This observatory possesses a complete series of self-registering meteorological apparatus, viz., barograph (Hasler), thermograph (Hasler), anemograph (Munro and Schulze), rain-gauge and evaporator (Hasler), and sunshine recorder (Campbell). Besides the instruments necessary for a station of the Second Order (erected in various ways), there is also apparatus for determining evaporation in the shade and from an open surface of water, earth-temperature at various depths, &c.

For magnetic observations the observatory is furnished (in addition to the apparatus for absolute determinations of the elements of terrestrial magnetism) with magnetometers (unifilar and bifilar magnetometers and a Lloyd's balance) and magnetometers for direct measurements of variation. The Observatory also possesses instruments for the determination of the intensity of earth currents and an electrometer for observations of atmospheric electricity.

The Physical Observatory at Tiflis, with the dependent meteorological stations of the Caucasus, is, as regards its scientific relations, under the

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superintendence of the Central Institution, and is dependent, administratively, upon the Government of the Caucasus. The director is nominated by the Academy of Sciences, upon the proposal of the director of the Central Observatory and is appointed by the governor of the Caucasus. In addition to the instruments required for the usual meteorological observations at a station of the Second Order the observatory possesses instruments for determining earth temperature at various depths, evaporation, radiation, &c. It has also the following self-recording instruments, barograph, thermograph, and anemograph by Hasler. For magnetic measurements, an altazimuth by Repsold and dip circles by Girgensohn and Dover are used; for observations of magnetic variation a unifilar magnetometer, a bifilar magnetometer and a Lloyd's balance are used.

The observatories at Catharinenburg, Barnaul, Nertschinsk, Bogoslowsk, Blagodat, Lugan, and Slatoust are managed by the Department of Mines and are only subordinate in their scientific relations to the Central Observatory. The three first-named observatories possess, in addition to the instruments for the usual meteorological observations, apparatus for magnetic measurements. In some districts there are central administrations for the more remote stations. For instance, the meteorological stations in Turkestan are superintended by the Observatory at Taschkend, those on the Black Sea by the Hydrographic section at Nicolaieff, and those on the coast of the Pacific Ocean by the Hydrographic section at Wladiwostok. The observations of these stations are sent to the Central Observatory, like those which belong directly to it, for examination and publication.

The staff, &c.

8. The following shows the distribution of offices charged to the vote of the Central Physical Observatory and of the filial institution at Pawlowsk :—

Central Observatory :—

	Salary. £
Director (in addition to his salary as Academician and a personal allowance)	270
Assistant to director	204
Scientific secretary	180
Two physicists (each)	180
Two junior observers (each)	120
Two computers (each)	60
Steward	75
Mechanician	67

Department for Storm Warnings and Ocean Meteorology—

Assistant of the director for the management of the department	204
Two physicists (each)	180
Two adjuncts (each)	120
One computer	60
Two draughtsmen (each)	72
One lithographer	54

In addition to these permanent officials there is the necessary number of computers, writers, and servants paid by wages, provided from special funds.

MEMORANDUM.—The director, the secretary, and the steward have apartments in the Observatory.

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Pawlowsk Observatory:—

	Salary. £
Superintendent - - - - -	360
One physicist - - - - -	240
Three junior observers (each) - - -	150
One mechanician - - - - -	150

The assistant of the mechanician and the servants are paid from special funds.

MEMORANDUM.—All the officials of the Pawlowsk Observatory have apartments provided.

The observers at the meteorological stations of the Second Order are generally volunteers, and receive no remuneration, excepting at the coast stations, those in Turkestan, and partly those in the Caucasus, where the observers are paid by the local Administrations.

Publications.

9. The observations from the observatories and from the meteorological stations in Russia are published in the Annals of the Central Observatory. The following volumes have hitherto appeared:—

"*Annales de l'Observatoire Physique Central*, 1848–1869," (in continuation of the "*Annuaire magnétique et météorologique*, 1835–1847," issued by the Administration of Mines).

"*Annalen des physicalischen Central-Observatoriums*, 1870–1881."

In the years 1850–1864 results of the observations and other communications were published in the "*Correspondances Météorologiques*."

The weather telegrams are all received free, and are published daily in the Bulletin, which has appeared since the year 1872. The Supplement to this bulletin contains papers on the mean tracks of the barometric minima and maxima, on the determination of the probable direction of the translation of depressions, and on remarkable phenomena of weather.

Discussions by the staff of the Observatory relating to meteorological and magnetical phenomena in Russia are published under the superintendence of the Director, Professor H. Wild, in the *Repertorium für Meteorologie* of the Academy of Sciences. Seven volumes and a supplement of this work have appeared.

Detailed information as to the position and the development of the operations of the Central Observatory and its subordinate institutions are given in the yearly Reports of the director. The volumes for the years 1859–64 have appeared under the title *Compte-rendu du Directeur* and from the year 1869 the *Jahresberichte* have been published, and in recent years have been printed in the *Repertorium für Meteorologie.*

The Tiflis Observatory publishes its observations *in extenso* and other meteorological data in the *Materialen zu einer Klimatologie des Kaukasus.*

Since the year 1880, when hourly observations were recommenced at this observatory these observations have been printed *in extenso* in *Meteorologische Beobachtungen des Tifliser physikalischen Observatoriums*," and in addition the observations of earth temperature are published separately. This observatory has also published since the year 1879 the "*Magnetischen Beobachtungen des Tifliser physikalischen Observatoriums.*" Of the other observatories *Dorpat* only publishes its observations, made at all the odd hours, under the title "*Meteorologische Beobachtungen in Dorpat.*"

Management and inspections.

10. The stations are inspected as far as posssible by the staff of the Central Physical Observatory. As however a long absence of these officials is inconsistent with the regular performance of their duties, the more remote stations of the empire can only be inspected very seldom.

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The stations in the Caucasus are from time to time inspected by the director of the Tiflis Observatory or by officials deputed by him.

Some attempts have also been made at inspecting their respective subordinate stations by the observatory in Taschkend, the Hydrographical Departments in Wladiwostok and Nicolaieff, but these have not been altogether successful, owing to the want of suitable persons.

Details as to the management of the stations have already been given under point 7.

Supplentary remarks.

11. For the maintenance of the meteorological institutions in Russia the Government expends the following amounts :

	£
1. Central Physical Observatory, with its various departments	6,723*
2. Magnetical and Meteorological Observatory at Pawlowsk	2,378
3. Physical Observatory at Tiflis	1,749
4. Magnetical and Meteorological Observatory at Peking	786
5. Maintenance of the Mine Observatories	1,080
6. „ Meteorological stations	600

The cost of maintenance of the Taschkend Observatory, with its subordinate stations in Turkestan, and the expenditure of the Ministry of Marine for meteorological purposes, are not accurately known.

Historical.

12. The first meteorological observations in Russia were made by the Academy of Sciences at St. Petersburg; these were begun in 1726. Then follow, in the second half of the last century, the following places, from which useful observations exist: Astrachan, Abo, Isolikanisk, Pischminsk, Ochotsk, Moscow, Warsaw, and Riga.

It was only in the present century that meteorological observations in Russia received a considerable impulse, when measures were taken for the establishment of meteorological stations by the Ministries of Marine and Instruction. We are indebted to the first for the establishment of stations at many ports, like Nicolaieff and Cherson, while the latter, on the proposal of the Wilna University, made in the year 1803 a regulation for meteorological observations, to be taken at all schools of the Wilna educational district. This regulation was extended in the year 1832 to other schools in the Empire, for in this year the Ministry of Instruction, at the instance of the Academy of Sciences, addressed a circular to the Universities and the upper and middle class schools, requesting that meteorological observations should be made in accordance with the instructions of the Academy. From this time meteorological observations quickly increased. The efforts of the Hydrographic Department of the Navy in establishing stations on all the coasts of the Empire, on the one hand, and on the other the very great sacrifices which the Mine Department of the Finance Ministry made in founding the magnetical and meteorological observatories at St. Petersburg, Catharinenburg, Barnaul, and Nertschinsk, and the meteorological observatories at Bogoslowsk, Slatoust, and Lugan, deserve especial mention. This not only gave the impulse for the establishment of similar observatories by other authorities in Moscow, Kasan, Tiflis, Pekin, and Sitka, but also led the Department of Mines in 1849 to establish the Central Physical Observatory, as an indispensable centre for the continuous superintendence of the observatories and the stations as well as the collection and publication of their observations. The Central

* In this sum are included the expenses of the various operations of the Central Observatory, which cannot be reckoned as properly belonging to a Central Institution or Meteorology and Terrestrial Magnetism.

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Physical Observatory soon became the depository of most of the meteorological observations in Russia. The endowment of this institution, which was absolutely insufficient both as regards staff and funds, soon led to the exhaustion of its existing power and to the rapid decrease of the superintending activity of the institution. The result of this was that the number of meteorological stations had considerably decreased about the beginning of the year 1860. A reorganisation of the meteorological service in Russia, which was begun both by the Ministries of Instruction and Marine in the year 1864, had no permanent result, because the Central Institution itself was not first reorganised. It was only since the year 1865, at the time when the Academy of Sciences (to which the Central Physical Observatory was then transferred) effected the reorganisation of the meteorological system, and especially of the Central Observatory, we see the number of stations in Russia and the quality of the observations entering a phase of rapid and constantly increasing development.

RUSSIA.—FINLAND.

Professor A. K. Nordenskiold, Central Meteorological Institute of the Society of Science of Finland.

(1.) The following particulars refer to the meteorological service of the Grand Duchy of Finland. Definition of the system.

(2.) In Finland there is really only one station of the First Order, that of Helsingfors. But, for the year of polar exploration, three temporary stations have been added; the meteorological and magnetical station of Södankylâ, in the polar regions, and the meteorological stations at Wasa and Wârtsilâ. Number and position of stations.

Helsingfors:	Lat.	60°	10′	22″	8	Long.	24°	57′	3″	8 Greenwich
Sodankylâ:	Lat.	67	25	—	—	Long.	26	36	—	—
Wasa:	Lat.	63	5	—	—	Long.	21	33	—	—
Wârtsilâ:	Lat.	62	10	—	—	Long.	30	38	—	—

Ten stations may be regarded as being of the Second Order, of which, however, at present the majority do not take hygrometric observations.

Twenty-five stations may be regarded as Stations of the Third Order, although they have been nearly all provided with very accurate mercurial barometers.

(3.) For want of self-registering instruments the observations are made by young male or female observers. At the stations of the First Order meteorological observations are made every hour, day and night, and at nearly all the Stations of the Second and Third Order they are made at 7h. a.m., and at 2h. and 9h. p.m. Organization of stations.

The Instructions are for the greater part in writing, and the observations (except those of Sodankylâ) are sent monthly to the Central Institute of Helsingfors, where the barometric and thermometric observations are checked by curves drawn graphically.

(4.) There are no special stations for observations of thunderstorms and hail. Since the year 1845 the Finland Society of Science has annually distributed special registers, all of the same form, for phenological observations. In 1882 such registers were returned from 57 stations. Special observations.

(5.) Maritime observations, strictly speaking, are not made here. At eight Pilot stations, which form a special class of stations, observa- Marine observations.

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tions are made of the height of the water, as well as of the direction and force of wind.

Ordinary meteorological observations are made at nearly all the light-houses of the Gulf of Finland and of the Baltic Sea.

Weather telegraphy.

(6.) The Central Meteorological Institute of Helsingfors receives daily meteorological telegrams from eight stations in Finland.

The meteorological telegrams sent from Norway and Sweden to St. Petersburg are copied on their way at Helsingfors; and a telegram from St. Petersburg giving the atmospheric condition of several places n Russia is received daily.

All these meteorological telegrams, when reduced at the Central Institute, are published in five daily newspapers at Helsingfors. As long as the navigation is open, the ports of Helsingfors and Hanga receive by telegraph storm warnings from the Central Physical Observatory of St. Petersburg.

The meteorological telegrams from the provincial stations are sent not only to Helsingfors, but also to St. Petersburg.

The Central Office.

(7.) In accordance with the decree of His Majesty the Emperor-grand-Duke of the 27th October 1881, the Magnetical and Meteorological Observatory of Helsingfors was reconstituted as the Central Meteorological Institute for Finland, while continuing to belonging to the Society of Science of that country. The temporary station of Sodankylâ, which is also subordinate to the same society, is independent of the Central Institute of Helsingfors.

For the purpose of buying new instruments, the Central Institute received, according to the same decree, a lump sum of 656*l.*; but from unforeseen circumstances the instruments have not yet been bought.

The staff.

(8.) The Director is the only regular officer of the Institute. His salary is 325*l.*, with an increase of 32*l.* 10*s.* after five years, and another 32*l.* 10*s.* ten years later, with apartments situated in the court of the Institute.

The Institute receives annually 800*l.* from the public funds for observations, and the maintenance of buildings, and furniture, attendance, lighting and other expense.

The computers and the observers at Helsingfors have 6*d.* an hour. The night observers have only 5*d.* an hour, but they are lodged free in the Institute. Only those provincial observers who forward daily meteorological despatches to the Institute receive remuneration.

At Hango the remuneration of the observer is 20*l.* per year, the other observers receive only 7*l.* 10*s.*

The observers at Wasa and Wârtsilâ are either paid from private sources, or they are persons interested in the science, and observe voluntarily.

Publications.

(9.) Besides the publication of the meteorological telegrams the Central Meteorological Institute publishes the "Månadsöfversigt of Väderleksförhållander of Finland," and the "Årsbok."

As far as possible it will also publish some of the valuable observations of earlier date.

This, however, could not be done in the year 1882, for owing to the small means at the disposal of the Institute it has had to concentrate its efforts in supplying the observatory at Helsingfors with new magnetical

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instruments, and in establishing the meteorological stations at Wasa and Wårtsilå.

In the "*Öfversigt of Finska Vetenskaps-Societetens Förhandlingar*," the Counsellor of State Moberg has for several years published a summary of phenological observations made in Finland, as well as those made on the height of the water near the pilot stations.

(10.) All the business of the Institute, the decision of which does not belong to the director only, must be submitted to a meteorological delegation named by the Society of Sciences of Finland. The more important questions are submitted with reports of the same delegation to the Society of Science. Management and inspections.

The audit of accounts and other property of the Central Meteorological Institute is made annually in March by the meteorological delegation.

In the same month the director has to submit to the Society of Sciences the annual report of the Institute.

The Society of Sciences has the right to send either the director or any other competent person to inspect the stations in the provinces, and to charge the expenses to the public funds.

(12.) The Economical Society of Finland, founded in 1798, has made meteorological and climatological observations at several places in Finland from the beginning of this century. Historical.

A part of these observations has been carefully treated in several works by Professor Hållstrom. Since the year 1840 a number of medical men, both in town and country, have been requested by the Central Council of the sanitary establishments to make meteorological observations, and they have worked zealously.

At the meeting of 2nd June 1845, Herr von Hartmann, chief of the above council, proposed to transfer tlie direction of meteorological matters to the Society of Science in Finland. This proposal was accepted, and the society determined to send accurate barometers and thermometers to various places in the following winter.

Since that time the Society of Science has continued to collect observations on the climatology of the country. The Society has had the meteorological stations inspected three times; in 1848, 1858, and 1871, Great progress has been made in the meteorological science of Finland by the establishment of the Magnetical and Meteorological Observatory at Helsingfors; for, up to the death, in 1848, of its founder, Professor Nervander, this establishment had done all that could be expected at that time, from such an institute.

From June 1844 until the middle of the year 1857 observations were taken every twenty minutes, day and night, and after that time once an hour.

The Observatory was established out of the funds of the University, and was constituted an integral part of it.

By a decree from His Majesty the Emperor Grand Duke this observatory was transferred on the 1st of July 1880 from the University to the Society of Sciences, and, as before stated, it was reorganised, in the year 1882, as the central establishment for the meteorological service in Finland.

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SWEDEN.

A.—*Dr. R. Rubenson, Central Meteorological Institute, Stockholm.*

Definition of system.

1°. The principal duties of the Swedish Central Meterological Institute may be comprised under the two following general heads:—

(1.) *Climatological Investigation of the Country.*—Management of the system of observations, including both official and private stations (*see below*), together with yearly publications of the observations of these stations and the utilization of the results.

(2.) *Weather Investigations.*—Telegraphic weather correspondence. Publication of the Daily Reports, and forecasts of weather.

Number and positions of stations.

2°. There is only one Station of the First Order in Sweden, viz., the Meteorological Observatory at Upsala, an establishment which is independent of the Central Office. It publishes an independent volume under the title of "*Bulletin mensuel de l'Observatoire Météorologique de l'Université d'Upsal.*"

The following systems of observations are dependent upon the Central Meteorological Institute.

The Stations of the Second Order are partly official, 33 in number, and partly private, 21 in number; 14 of the latter have been fitted up by the Economical Society. To these may be added the forest stations, which are provided for by the forest administration (*see* § 4).

321 stations may be considered as Stations of the Third Order, at which only observations of precipitation and partially of air temperature are taken. These stations are for the most part fitted out with instruments at the cost of the Economical Societies of the different Government districts.

With regard to the Stations of the Fourth Order, at which special observations are made without any instruments (*see* Section 4).

Organization of stations.

3°. With respect to the outfit of the Meteorological Observatory at Upsala, a special report has been communicated to the International Meteorological Committee by its director, M. Hildebrandsson.

The Stations of Second Order are supplied with the following instruments:—

1. Siphon barometer.
2. Two thermometers (Psychrometer) by Åderman.
3. Rain-gauge, with two measuring glasses.
4. Some stations have wind-vanes.
5. All stations have maximum and minimum thermometers.

The hours of observation are generally 8h. a.m., 2h. and 9h. p.m.

The following instructions have been issued to the observers:—

1. Edlund, E., "*Handledning vid meteorologiska observationers* anställande för de af K. Vetenskaps—Akademien för detta ändamål antagna observatörer." Stockholm, 1858, 8°.
   Do. Second edition, by H. E. Hamberg. Stockholm, 1882, 8°.
2. "*Om psychrometerns skötsel.*"
3. "*Kort instruktion för anställande af meteorologiska observationer.*"
4. "*Instruktion för observation af maximi—och minimi thermometrar.*"
5. "*Instruktion för mätning af nederbörden.*"

For the reduction of the observations, Guyot's tables are generally used, and for hygrometric observations Jelinek's Humidity Tables.

The checking of the observations is effected partly by inter-comparison of the registers of different stations and partly by inspections.

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4°. The Forest stations, the expense of which is borne by the Forest Administration (now the Administration of Domains) have been established under the direction of the Central Meteorological Institute, and are under its management. Two of these (Forest and Field stations) are in the district of Skaraborg, three in Vestmanland, and one (a Forest station) in Upland. To this system also belongs a tidal station at the mouth of the Clara, and some rain stations. Special systems of observations, Stations of the Fourth Order, exist also for the following phenomena:— Special observations.

(1.) Thunderstorms and hail, 97 stations.
(2.) Freezing and breaking-up of the ice in the lakes, 79 stations.
(3.) Phenological phenomena, 108 stations.

5°. Maritime observations are under the direction of a special institution, the Nautical Meteorological Office at Stockholm, the duties and organization of which are stated in a special report to the International Meteorological Committee by the Director of that office, Captain F. Malmberg. Marine observations.

6°. The Central Meteorological Office receives weather telegrams daily from 9 inland and 21 foreign stations, made at 8 a.m., and the previous evening, and from 3 Swedish and 2 foreign stations, at 2h. p.m., viz.:— Weather telegraphy.

Morning Telegrams from—

Haparanda.	Borkum.
Hernösand.	Hamburg.
Falun.	Swinemünde.
Upsala.	Neu-Fahrwasser.
Stockholm.	Krefeld.
Carlstad.	Leipzig.
Gothenburg.	Breslau.
Wisby.	Archangel.
Karlshamn.	Hangö.
Bodö.	St. Petersburg.
Christiansund.	Riga.
Skudesnæs.	Dunrossness.
Oxö (Christiansand).	Aberdeen.
Copenhagen.	Yarmouth.
Fanö.	Valencia.

Afternoon Telegrams from—

Haparanda.	Stockholm.
Gothenburg.	Skudesnæs.
Aberdeen.	

Also a morning telegram from France, containing 8h. a.m. observations. This collective telegram, however, generally arrives too late to be of immediate use.

With this material, a synoptic chart is constructed daily between 12 and 1 o'clock. and a summary of the weather over Northern Europe is prepared, with probabilities of impending weather. A report of the morning telegrams is made available without delay for the general public, (1) by posting it up at several places in the capital, (2) by communicating it to the Stockholm daily papers, one of which, the "Aftonbladet," is supplied with a synoptic chart, and (3) by sending a concise summary, accompanied with the forecasts, to the Railway Administration, which communicates them by telegraph to its principal

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stations in order to make them available to the general public by exhibition there.

The daily weather reports from Sweden, together with those from Norway and Denmark, are published fortnightly in the "*Bulletin du Nord.*"

The Central Office.

7°. The Central Meteorological Institute is under the supervision of the Royal Academy of Sciences, but is more directly under the superintendence of two of its members, who are appointed as Visitors. The institution has two permanent officers, viz., a professor and a secretary, who are appointed by the Academy, on the nomination of its Physical Class. The Institution possesses no special meteorological observatory. It is situated in the buildings of the Academy. All expenses are met out of the Government funds.

The staff.

8°. The professor receives a yearly salary of 220*l.*, with 55*l.* so-called "service money," and two increments of 27*l.* 10*s.* each after five and ten years' service.

The secretary receives 137*l.* 10*s.* a year.

There is also a servant (who acts as telegraphist) attached to the Institution at a salary of 38*l.* 10*s.* (Since January 1, 1883, the salary has been 55*l.*)

The computations are carried out by supernumerary assistants. In the year 1882 these were seven in number.

The observers at the official stations receive a remuneration of 11*l.* a year.

Publications.

9°. The observations of the stations of the Second Order are published up to the present time by the Royal Academy of Sciences in the annual volume "*Meteorologiska Jakttagelser i Sverige,*" under the superintendence of the Central Meteorological Office. Volumes 1–6 (1873–8) of the second series of this work have appeared. These form parts 15–20 of the whole work.

The results of rainfall and temperature for many years have been published in several papers in the "*K. Sv. Vet. Akad. Handlingar,*" vols. 12–14.

The rainfall observations at all the stations of the country, both public and private, are published by the secretary, Dr. E. Hamberg, in a monthly periodical, entitled "*Månadsöfversigt af väderleken i Sverige.*" This publication is under the supervision of the Central Meteorological Office.

Management and inspections.

10°. Each year some official stations, and generally some private stations, or forest stations, also are inspected.

Historical.

12°. The Swedish system of meteorological observations was established by Professor Edlund in the year 1858, and transferred to the Central Meteorological Institution upon its foundation on the 1st January 1873. Since that time, besides a considerable increase of official stations, all the private stations of the Second and Third Orders, forest and rain stations, have been started. The system of special observations of the state of the ice, thunderstorms, and phenological phenomena, was transferred in the year 1881 to the Central Meteorological Office from the Meteorological Observatory at Upsala.

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B.—*Captain F. Malmberg, Nautical Meteorological Office, Stockholm.*

1°. The Nautical Meteorological Office, which was organised in the year 1878, and commenced operations in the year 1879, collects and utilizes all the meteorological observations which are made on board Swedish ships, both of those which make long voyages and also those which navigate the Baltic, the Cattegat, and the North Sea. It superintends and discusses the meteorological and physical observations which are made at Swedish lighthouses and lightships; it also renders service to navigation by purchasing and supplying other instruments besides those for meteorological purposes to seamen, so far as funds are at its disposal, and by purchasing and rendering available books and charts which are of importance from a nautical and meteorological point of view, and which are not in the collection of the Hydrographic Office. It also prepares meteorological reports and other information for seamen, from the results to be derived from meteorological and scientific treatises. Definition of system.

2°. There are 19 meteorological stations of the Third Order belonging to the Institution, and 19 rainfall stations, all of which are situated at the lighthouses of the kingdom. Number and positions of stations.

3°. The meteorological stations are all provided with barometers, thermometers, Hagemann's hand wind-gauges and with rain-gauges. Two of the stations, Bremö and Kungsholmen, have also maximum and minimum thermometers. Organization of stations.

With respect to the form and exposure of the instruments, plans will be found in the "Instructions for meteorological observations taken at Swedish lighthouse stations" (No. 4). The hours of observations are the same as those at the official stations of the Central Office, viz., 8 a.m. 2 and 7 p.m.

5°. Meteorological observations, in complete accordance with those prescribed in the English meteorological log, are now made on board 25 merchant ships, and in those ships of the Royal Navy which visit distant seas, and after extracts have been made from the logs of all that is of interest to the institution, the logs are sent to the meteorological institute at Utrecht, in order to be utilized there in connexion with other similar observations, as the observations are not sufficient for independent discussion. Marine observations.

The instruments necessary for the above-mentioned merchant ships are lent without charge by the office. There are also 15 hydrographical observing stations connected with the Office, 8 of which are on board lightships, and 7 are land stations.

At the lightships and at two of the shore stations daily observations are made at 8 a.m. of the direction and force of wind, temperature of the sea and its specific gravity, both at the surface and at three different depths fixed for each station, together with the direction and rate of the current. At the five other stations the observations are restricted to the temperature and specific gravity of the sea surface and the direction of the current. For the instruments used at these stations we refer to the "Instructions for hydrographic observations made at Swedish light and pilotboat stations (No. 5)."

8°. With the exception of the Director of the Office, who is paid by the Government, there is no one permanently attached to it, but temporary assistants are engaged when necessary. The observers, who are light-keepers, receive no pay from the Office, excepting those who take The staff.

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hydrographic observations at the land stations, but all these observers, as well as the captains of ships who keep meteorological logs for the Office, receive a copy of M. Rubenson's "Handbok i Nautisk Meteorologie."

Publications.

9°. The following instructions have been published by the Office :—

(*a.*) "Instruktion for meteorologisk logboks förande" (No. 1).
(*b.*) "Meteorologisk anteckningsbok" (No. 2).
(*c.*) "Väderleksbok" (No. 3).
(*d.*) "Instruktion for meteorologiska observationers utförande vid "Svenska fyrstationer" (No. 4).
(*e.*) "Instruktion for hydrografiska observationers utförande vid "Svenska fyr och lotsstationer" (No. 5).
(*f.*) "Hydrografisk observations Journal" (No. 6).
(*g.*) "Instruktion for Nederbörds mätnings-observationers utförande vid Svenska fyrstationer" (No. 7).*

Management and inspections.

10°. The Office is under the superintendence of the Admiralty, and the business of the office is managed by a Superintending Committee, composed of the chief of the Hydrographic Office, the Director of the Central Meteorological Office, and the Director of the Nautical Meteorological Office.

The Director of the Office undertakes yearly tours of inspection, and during his absence his duties are performed by the Chief of the Hydrographic Department, in whose establishment the Nautical Meteorological Office is located.

C.—*Dr. H. Hildebrandsson, Observatory, Upsala.*

Meteorological observations have been made at the Astronomical Observatory at Upsala two or three times a day from the beginning of the last century. The first manuscript, which is still here, is for the year 1722, but bears the number 9. At that time Erick Burman was Professor of Astronomy. The oldest manuscripts are in his handwriting. These oldest observations were published in extract in the *Acta Litteraria*. The *Acta Litteraria* were the earliest publications of the Royal Society of Sciences at Upsala. Burman and his coadjutor and successor, the renowned Anders Celsius, organised a regular system of observations, embracing many stations in Sweden. The registers were sent to Upsala and many of them are still preserved in the Meteorological Observatory. Most of them, however, appear to have been lost. The Upsala registers have been continued with few exceptions until the present day. The registers of the first 10 years, and after a gap between 1732–38 inclusive, the following ten-yearly periods, have been kept very well according to the conditions followed at that time, by Hiorter, the adjunct and fellow-worker of Celsius.

Towards the close of the last and the beginning of the present century the observations were made very badly. M. Gustave Svanberg first introduced good order in the beginning of the decade of 1830-40, and since that date the registers are trustworthy. He published the observations for 1855–62 *in extenso* in the *Résultats des observations météorologiques*

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* A copy of each of these accompanied this letter.

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faites au nouvel observatoire d'Upsal. The new observatory, outside the town, was opened in 1853. The observations in the "Résultats" are generally good, but the exposure of the wind-vane at that time left much to be desired.

In the year 1864 a department for meteorology was organised at the observatory. At first, however the work was done entirely by volunteers. Dr. R. Rubenson, now Director of the Central Office in Stockholm, P. G. Rosén, now Professor and Chief of the Geodetical Surveys in the Royal Staff Corps, and the undersigned formed a society for meteorological observations among the students. A little stone building was erected and the observers were carefully trained by us. On the 30th May 1865 hourly observations were begun under Rubenson's superintendence. The observers were told off for continuous hours, and observed day and night every hour until the 9th August 1868. *Not a single observation was lost*, and the series obtained is without doubt one of the most complete and most trustworthy that exists. The work was quite voluntary and gratuitous, and the publication of the results was made by free contributions of many persons under the title "*Observations météorologiques horaires exécutées par une société d'étudiants, á l'observatoire de l'Université d'Upsal, dirigés et publiés par R. Rubenson.*"

In the year 1868 Svanberg had brought matters so far that the first meteorograph was purchased and erected in the above-mentioned house. It was one of Theorell's older construction, described in *Theorell's "Description d'un météorographe enregistreur construit pour l'Observatoire d'Upsal. Nova Acta Soc. Reg. Scient. Ups.,"* vol. vii. No. 11; also in the "*Zeitschrift d. öster : Gesellschaft für Meteor.,*" vol. iv. p. 497. A self-registering wind-vane had been previously erected there. At the same time Svanberg succeeded after strenuous exertions in carrying on his meteorological department at least as an extra department of the University. Rubenson was appointed adjunct and chief of the meteorological department of the University by the Chancellor of the University, and received a salary of about 220*l.* In addition, two assistants were engaged, and paid about 38*l.* The observations from December 1869 have been published in the "*Bulletin Mensuel,*" and the cost of this publication is divided between the University and the Royal Society of Sciences. All other publications are provided for by the Observatory. The undersigned was sent abroad in 1869 in order to study modern meteorological work. His report is published in the "Årskrift" of the University. In 1871 he succeeded, with the co-operation of the Royal Agricultural Society, in organising in each Government of Sweden a system of observations at about 300 Stations. These stations observed thunderstorms, night-frosts, ice-conditions of the lakes, rivers, and streams. The registers were forwarded to the Observatory at stated times, and the discussion was carried on there by himself gratuitously. The observations were increased in 1873 by phenological observations and at some stations by cirrus observations.

When Dr. Rubenson was appointed Director of the new Central Office in Stockholm in 1872, I undertook, as his successor, the management of the Meteorological Department of the Observatory at Upsala. In 1873 a Robinson's anemograph was erected, and in the following year I obtained the necessary funds for procuring and setting up a Theorell's printing meteorograph. See "*Theorell: Description d'un "Météorographe imprimeur construit aux frais du Gouvernement, "K. Wet. Akad., s.j. Stockholm.*" *Handlingar,* Bd. 10, 1871. The

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two assistants were then discharged, and in their stead a permanent assistant was appointed, with a salary of 55*l.*

In 1878, after Professor Svanberg had resigned, the Diet, on the proposal of the Government, voted the funds for the separation of the Observatory, and consequently an independent Meteorological Observatory was established.

The staff consists of two persons only, the Director, with salary as Professor at the University; one assistant, with a salary of 55*l.* In addition, we received for all other expenses 165*l.*, and in 1882, 280*l.* This amount includes the expenses of computers and the publication of the "*Bulletin Mensuel.*" On the other hand, we have from the University fire and attendance, and free postage is specially granted by the Government, for all communications to and from the Observatory.

We are in telegraphic communication with the Central Office in Stockholm, but being an institution of the University we are independent of that office. The above-named Stations of the Third Order which I established in 1871 and superintended for 11 years, were, upon my proposal taken over by the Central Office. Only the cirrus observations are now sent here.

Our means are consequently very limited. Happily volunteers are never wanting among the older students, so we do not suffer from want of working power. Our greatest want is a building of our own, and I have the hope that we shall get this in the immediate future.

The position of the Meteorological Observatory at Upsala in 1882 is as follows:—

Staff.—Director, with salary as Professor at the University
Assistant, with salary, 55*l.*
Two computers paid by piecework.
Expenses, 280*l.*
Official Publication, Bulletin mensuel de l'Observatoire Météorologique de l'Université Royale d'Upsal.
Meteorographs.—(1.) Theorell's first meteorograph, for barometer and dry and wet thermometers, has been in operation since 1868.
(2.) Theorell's printing meteorograph, since 1874.
(3.) A mechanically registering wind vane, since 1866.
(4.) A Robinson's anemograph.
(5.) A self-recording rain-gauge, under construction.

SWITZERLAND.

Dr. R. Billwiller, Swiss Central Meteorological Office, Zürich.

Definition of system.

1. The present meteorological service in Switzerland is mostly composed of volunteer stations. Meteorological observations are only made officially at the cantonal observatories of Geneva, Berne, Neuchatel and Basle, as well as at the Federal Observatory at Zürich. The object is to determine the climatic conditions of the country. The results of the observations are discussed scientifically by the Central Office (*see* No. 7), and in doing this particular attention is paid to local peculiarities of climate in their relation to their elevation of the land.

Number and positions of stations.

2. Berne is the only Station of the First Order, according to the definition of the Congress—

Lat. 46° 57′ N., Long. 7° 26′ E. Height, 1,880 feet.

There are 75 Stations of the Second Order, including Geneva, St. Bernard, and Säntis. At Geneva and St. Bernard observations are

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made every two hours from 6h. a.m. till 10h. p.m. At Säntis direct observations are taken at 7h. and 10h. a.m., 1, 4, and 9 p.m., and pressure is recorded hourly by a Höttinger's barograph. In the coming summer an anemograph by Munro will be erected, and the station will be raised to the rank of the First Order, by further additions to its outfit.

Organization of stations.

3. The station of the First Order, at Berne, possesses two sets of electrically registering instruments by Hasler of Berne, for temperature, pressure, relative humidity, wind-direction, and force and rainfall.

The stations of the Second Order are supplied with cistern barometers, dry and wet bulb thermometers (some stations use Höttinger's percentage hair hygrometer instead of the wet bulb thermometer), wind vanes with Wild's pressure-plate, and rain-gauges.

The stations of the Third Order all observe at least temperature and rainfall, and keep a record of the state of the weather. There is also now a system of rainfall stations distributed over the whole country, which we include in a special category. At the end of 1882 there were 165 of these stations at work in the cantons of Zürich, Thurgau, Schaffhausen, Zug, St. Gall, Appenzell, Aargau, Basle, Lucerne, Freiburg, Schwytz, and Waadt. The hours of observation are 7h. a.m., 1h. and 9h. p m., except at Geneva and St. Bernard; and 7h. a.m. at the rainfall stations.

The instructions in use are those issued by the former Meteorological Commission of the Swiss Naturalist's Society :—"*Instructionen für die Beobachter der meteorol. Stationen der Schweiz. Zürich*, 1863." The changes which have become necessary by the decisions of the Congress have been communicated to the observers by special circulars.

The tables used for the barometer are Kämtz's, with the suppression of one decimal figure; and for the hygrometer, Regnault's tables.

The observations are checked at the Central Office, and the partly uncorrected and partly reduced observations are critically examined and the errors corrected by the help of the observations from neighbouring stations.

Special observations.

4. Thunderstorms and hail will be observed from the year 1883 at a great number of special stations. For this purpose the rainfall stations will above all be turned to account. Special instructions are supplied to the forest officials for the observation of hail.

Weather telegraphy.

6°. 73 Stations send observations to the Central Office at Zürich by telegraph twice a-day. Some of the telegrams contain the observations of the previous evening, and of the early morning; some contain the last-mentioned observations and those of 1h. p.m., and others those at all three hours. A collective telegram containing evening and morning observations from five stations is sent about 10h. a.m. to Vienna and Rome, and another containing the morning and midday observations from two high level stations is sent to Hamburg about 2h. p.m.

The Swiss Central Office receives from the three central offices just mentioned collective telegrams containing the morning observations from a number of stations from their own neighbouring systems. The Central Meteorological Office in Paris receives the observations from Berne only, and sends its despatch, drawn up for the Agricultural Service, with the summary of pressure, to Switzerland.

Upon the basis of these reports a summary of the weather is prepared, and synoptic charts are drawn up, with a forecast for the following day. A report is delivered to the Telegraph Office between 2h. 30m. and 3h. p.m. for transmission to subscribers, the telegraph authorities granting a considerable reduction on their ordinary rates.

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The Central Office.

7. The Central Office, which is located at Zürich, has been a Government institution since the 1st May 1881. It is not at present an observatory, but only a central office for the collection, publication, and discussion of the observations. It is superintended by a scientific commission appointed by the State, and consisting of seven members. The Commission holds one or two meetings a year for the consideration of questions of organisation, and for preparing the estimates. The Central Office has not yet a building of its own, but is at present located in the private house of its Director. It possesses a number of instruments, which are, however, not used for regular observations, but only for occasional investigations, and for checking other observations.

The staff.

8. The staff consists of the Director and an adjunct, appointed by the Federal Council, and assistants appointed by the Director. The latter, in 1882, numbered three computers. The salary of the Director is 180*l.* to 200*l.*, that of the adjunct, 100*l.* to 120*l.* The computers are paid 48*l.* to 60*l.* for seven hours work daily.

From 12 to 15 of the observers (the number varies from year to year) receive from 2*l.* to 4*l.* on returning uninterrupted and reliable registers. Most of the observers, however, decline any remuneration.

Publications.

9. The publications of the Central Office are :—

(*a.*) "*Annalen der schweiz. meteorol. Centralanstalt*," which formerly appeared under the title "*Schweizerische meteorol. Beobachtungen.*"

(*b.*) Daily weather reports.

The first publication contains the results of the observations of all the stations, and a supplement with meteorological discussions; the second contains the weather reports from about 14 Swiss stations, and a chart containing also foreign telegraphic weather reports and a summary, with a forecast for Northern Switzerland.

Management and inspections.

10. The stations are managed by the Central Office. The Director or the adjunct conducts the correspondence, and the latter represents the Director during his absence. The Director undertakes the management of the financial administration of the Central Office and stations.

The inspection of the stations and verification of the instruments at the stations (Kew thermometers and check barometers by Fuess) with standard instruments, are also undertaken by the Director and adjunct. Each station has to be inspected at least once in three years.

Supplementary remarks.

11. Free postage, the same as is enjoyed by public offices, is allowed for the official correspondence of the Central Office and stations.

Historical.

12. Meteorological observations were made in the last century at various places in Switzerland, and have been partially published in the earlier volumes of the "Annals of the Central Observatory." These, however, have only a local importance and are not comparable, owing to the uncertainty as to the quality and exposure of the instruments, and to the diversity of hours of observation. Upon the proposal of M. A. Pictet, a commission of the Swiss Naturalist's Society was appointed in 1823, for the purpose of organising a system of meteorological observations. Good instruments were erected at 12 places Lausanne, Berne, Basle, Geneva, Solothurn, Lucerne, Aarau, Zürich St. Gall, Chur, Bellenz, and Schaffhausen, and afterwards on the St Bernard and at Bevers, and observations were taken on a uniform plan. Details of the observations were printed in various publications, but owing to the want of central guidance, for which there were no funds at that time, the undertaking led to few results.

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At the beginning of 1860 a plan for a system of meteorological observations was again discussed by the Swiss Naturalist's Society, and was carried out in 1863 by its permanent Meteorological Commission, of which Professor R. Wolf, Director of the Federal Observatory at Zürich, was for many years president. The Government (The Federal Council) assisted the undertaking by a yearly grant, amounting at first to 440*l.*, and afterwards increased to 600*l.* The Cantons also subscribed something towards the publications. As it was gradually found that practical interests were involved, besides the first merely scientific importance of the meteorological observations, the Meteorological Commission itself proposed to the Federal Council, with especial regard to Resolution 23 of the Vienna Congress—according to which each country should establish a Government office, for the superintendence, collection, and publication of meteorological observations—the re-organisation of the Central Meteorological Office and its elevation to the rank of a Government institution. In accordance with the decree of the Council this took place on the 23rd December 1880. On the 1st March 1881 the Central Meteorological Office of the Naturalist's Society, which generally had only the name of "Meteorological Office" was closed, and the "Swiss Central Meteorological Office" took its place, as a Government Institution, under the Federal Department of the Interior, independent of the Naturalist's Society. The chief of the former office was appointed Director of the new Institute.

THE UNITED STATES.—MISSOURI.

Professor F. E. Nipher, Physical Laboratory, of Washington University, St. Louis.

The Missouri Weather Service is not a State or Government institution, but is carried on wholly on private means. It is wholly a volunteer service, and is conducted not on account of what it is now doing, but with a view of finally securing the organisation of a Weather Service and a system of harvest warnings as a State institution.

At present we only attempt to observe rainfall and occasional phenomena.

The work has been carried on since 1877.

It is possible that in course of eight or ten years the State Government will see the advantages of having the work done in a more thorough and business-like way, and will extend the necessary co-operation. Until then we are only aiming to keep the sacred fires burning.

I. The aim is to make rain observations and observations on phenomena.

II. We have no stations where complete observations are made.

III. The instructions are those of the International Congress so far as observations are taken.

IV. It is impossible, under present circumstances, to give the attention to the direction of observers work, necessary to secure uniformity or completeness of observations on phenomena. Stations 35 in number.

VII. At the Central Office observations are taken at 7, 2, 9, on temperature, pressure, sky, and maximum and minimum temperatures are observed.

VIII. The director is assisted by a student who receives a nominal salary of $150 a year.

IX. Monthly bulletins are published, but no other publications of a strictly meteorological character have appeared.

X. There is no regular inspection of stations.

XII. Observations began December 1, 1877.

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APPENDIX XII.

Royal Observatory, Brussels.

Replies to Appendix V. of the Report of the Congress at Rome *. (*Received April* 1882).

1°. Our system possesses 116 stations:—

(*a.*) 4 of the First Order.
(*b.*) 38 of the Second Order.
(*c.*) 38 of the Third Order.
(*d.*) 36 of the Fourth Order.

2°. All the stations of the First, Second, and Third Order are provided with instruments. The stations of the Fourth Order are stations for the observation of thunderstorms only. The Stations of the First Order possess van Rysselberghe's meteorograph and instruments for direct reading; the Central Station at Brussels possesses besides a complete collection of photographic self-recording instruments.

The stations of the Second Order are furnished with a Baudin's barometer (graduated on the tube), Baudin's meteorological frame (maximum and minimum thermometers and dry and wet bulb thermometers), and a rain gauge.

The stations of the Third Order have only a rain gauge.

All the observations, both direct and automatic, are published in the "Meteorological Annals of the Royal Observatory of Brussels" and in the "Meteorological Observations made at the International Stations of Belgium and of the Netherlands." In this last collection the observations made each day at the four stations of the First Order at 8h. a.m., and at 1h. p.m. are published; in the Meteorological Annals the complete observations at Brussels for every two hours, the monthly *résumés* of the stations of the Second and Third Order, and the annual discussion of thunderstorm observations are to be found.

3°. All the stations are inspected yearly, or at least every two years, by the inspector. All the barometers were compared at the stations in 1877, and most of the thermometers are verified each year by the observers themselves. Comparisons are also made by the inspector, at the time of his annual visits. All the instruments, with very rare exceptions, are of suitable construction, all are carefully checked and compared at the Observatory before they are sent to the observers.

4°. At Brussels, six times a day:—8, 9, Noon, 1, 3, and 9. At all the other stations, twice a day, 8h. a.m. and 1h. p.m.

5°. The observations are entered on printed forms furnished by the Royal Observatory at Brussels. These forms are sent to Brussels during the first days of each month.

6°. The cost of these forms is borne by the Central Office.

7°. All the observers are volunteers; three only receive a slight remuneration. The Central Office repays the cost of postage of the monthly forms if claimed. The observers offer their services voluntarily.

8°. They are only changed at their own request.

9°. The stations are generally inspected between July and October.

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* See also replies at p. 42.

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10°. By the inspector and at the expense of the Central Office.

11°. The instruments are generally furnished by the Observatory, some observers purchase them.

11A°. They are all compared and verified at Brussels before being sent to the observers. They are verified again during the annual inspections.

12°. A director, a meteorologist in charge of the service, an inspector, a meteorologist, a joint meteorologist, and two assistant meteorologists.

12A°. None.

12B°. From 9h. a.m. till noon, and from 1 a.m. till 4h. p.m., except the joint meteorologist who attends from 8h. a.m. till 8h. p.m.

12C°. The director has free apartments in the Observatory.

13°. The director superintends the general work of the meteorological department, undertakes the correspondence with the Government and with foreign countries. Once a month he assembles all the meteorological staff in his office, in order to discuss questions relating specially to the service. It should be observed that the Brussels Observatory comprises two distinct departments, Astronomy and Meteorology, both entrusted to the same director.

All the staff takes part in the observations, but the joint meteorologist undertakes the greater part of them; the whole staff also takes part in the reduction of the observations.

The meteorologist in charge of the service and one of the assistant meteorologists have principally the charge of the self-registering instruments.

The inspection of the meteorological stations and the correspondence with the stations are undertaken by the inspector, who is also the librarian of the Observatory.

The discussion of the thunderstorm observations is also done by the inspector.

The meteorologist in charge of the service is almost exclusively occupied with the reduction of the observations made by the van Rysselberghe Meteorograph.

The daily weather report is drawn up by the joint meteorologist.

14°. The three meteorologists are nominated by the King, the other officials by the Minister of the Interior.

15°. Mean salaries: The director, 320*l.*; the meteorologist in charge of the service, 200*l.*; the inspector and the meteorologist, each 96*l*; the assistant meteorologists, 48*l.*

16°. The salaries are paid by the Government.

16A°. The salaries are permanent, and rise from a minimum to a maximum. All the officials have the claim to superannuation after 65 years of age, and 50 years of service.

16B°. Any funds remaining from the vote for salaries serves to pay the cost of additional or extra work. This residue is variable, on an average about 40*l.*

17°. The following are the meteorological publications of the Observatory:—

1°. Annals, of which the first volume of the third series has just appeared.

2°. Meteorological Observations taken at the International Stations of

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Belgium and the Netherlands, 1877–79; published in co-operation with the Meteorological Institute of Utrecht.

3°. Weather Report, published daily since the month of September, 1876.

4°. *Annuaire*, published yearly, but which is a publication referring to the whole of the Observatory, and not to the meterological service only, 1833–81.

17A°. There is a special fund for the printing of the different publications.

17B°. About six hundred copies of the publications are distributed at home and abroad, excepting the Weather Report, of which only about two hundred copies are distributed free.

17C°. The publications are not on sale, excepting the Weather Report and the *Annuaire*. The former numbers about 300 subscribers; the sale of the latter amounted this year to 1,300 copies. It is sold at the profit of the printer, who prints extra copies for this purpose.

18°. The daily observations of the Stations of the First Order are published.

For all the other stations only the monthly results are published.

19°. The discussion of the thunderstorm observations only forms a part of the regular work of the Observatory. The study of all the other meteorological questions forms a part of the voluntary work of the staff.

20°. The staff is constantly occupied with improvements or modifications to be introduced in the instruments. One of the meteorologists, M. van Rysselberghe, is well known by the invention of his universal meteorograph. Comparisons of instruments based upon the same principle but of different construction, are frequently made.

21°. 1°. 240*l.* for the first outfit of the stations.

2°. Stations without cost in public establishments, or belonging to private persons.

3°. Most of the observers are volunteers, three receive altogether about 6*l.* 10*s.*

4°. 60*l.* a year for gas, and maintenance of batteries.

5°. 4*l.* a year.

6°. 16*l.* a year.

7°. 12*l.* a year.

8°. No storm warnings.

9°. No vote for this purpose.

22°. The Observatory of Brussels occupies itself with the meteorology and magnetism of the Globe, and, in a certain point of view, with maritime meteorology. The mail-packet boats which run between Ostend and Dover are provided with instruments by the Observatory; the lightships of Westhinder and Weislingen constitute Stations of the Second Order. The Observatory sends a daily notice to the ports, and in case of barometric depressions, it sends a notice to the mines.

Replies to Appendix VIII. of the Report of the Congress of Rome.

4. Continuous observations, by means of self-registering instruments, have been made at the Brussels Observatory for 40 years; lately van Rysselberghe's meteorographs have been erected at Ostend, Arlon, and Maeseyck, that is to say, at the three angles of the Belgian territory.

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5. The observations are published in accordance with the forms proposed by the Congress of Vienna.

6. The figures adopted for meteorological telegrams are the same as those proposed by the committee.

9. The Observatory of Brussels will very shortly draw up the list of printed and manuscript observations made in the country. It is also preparing a second edition of the catalogue of the library, considerably augmented.

10. The standard barometer and thermometer of the Observatory were compared at Kew Observatory during 1880.

13. M.M. Quetelet, senior and junior, have published various memoirs on the range of temperature at Brussels. M. Lancaster published last year a work on the thunderstorms in Belgium.

14. The Brussels Observatory possesses specimens of various kinds of self-registering instruments—van Rysselberghe's, photographic, Kreil's, Osler's, Thomson's, &c.

15. The reduction of the barometer to sea-level is done in accordance with the decisions of the Congress.

17. Stevenson's screen has hitherto been employed. Latterly Renou's screens, with double roof and without louvres, have been erected. Comparative experiments on the two systems will be commenced soon.

23. For a long time the wind-force was measured by Osler's anemometer, which indicates, as is known, the pressure of the wind in kilograms. Since 1878 this instrument has been replaced by Robinson's anemometer, which measures the velocity of the air in motion. It was soon found that the indications of one of these instruments alone was not sufficient for the study of the various questions relating to the force of the wind, and it is proposed to observe both instruments at the same time when the new Observatory is built.

24. We are erecting an instrument which will enable us to studyt distribution of atmospheric electricity in successive strata of air placed in the same vertical.

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LONDON: Printed by EYRE and SPOTTISWOODE
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For Her Majesty's Stationery Office.
[1237.—500.—11/83.]

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LIST OF PUBLICATIONS, &c. issued under The Authority of the METEOROLOGICAL COUNCIL.

OFFICIAL.

No.

1. Report for 1867. 1s.
2. Instructions for Meteorological Telegraphy. New Edit. (1875). 6d.
3. Fishery Barometer Manual. 6d.
4. Charts of Surface Temperature, South Atlantic Ocean. 2s. 6d.
5. Report for 1868. 5d.
6. Report for 1869. 10d.
7. Quarterly Weather Report for 1869.—Parts I. to IV. 5s. each.
8. Barometer Manual. (Out of print; see Nos. 24 and 40.)
9. Quarterly Weather Report for 1870.—Parts I. to IV. 5s. each.
10. Report for 1870. 10d.
11. Contributions to our Knowledge of the Meteorology of Cape Horn and the West Coast of South America. 2s. 6d.
12. Currents and Surface Temperature of the North Atlantic Ocean, from the Equator to Lat. 40° N., for each month of the year. With a General Current Chart. 2s. 6d.
13. A Discussion of the Meteorology of the Part of the Atlantic lying North of 30° N., for the Eleven Days ending 8th February 1870. Price, with Book of Charts, 5s.
14. Quarterly Weather Report for 1871.—Parts I. to IV. 5s. each.
15. Report for 1871. 10d.
16. Quarterly Weather Report for 1872.—Parts I. to IV. 5s. each.
17. Report for 1872. 1s.
18. Contributions to our Knowledge of the Meteorology of the Antarctic Regions. 2s.
19. Quarterly Weather Report, 1873.—Parts I. to IV. 5s. each.
20. Charts of Meteorological Data for Square 3. Lat. 0°–10° N., Long. 20°–30° W.; and Remarks to accompany the Monthly Charts, which show the Best Routes across the Equator for each Month. 2s.6d. 20s.
21. Report of Proceedings of the Meteorological Congress at Vienna. 1s.
22. Report for 1873. 4d.
23. Report of the Proceedings of the Conference on Maritime Meteorology held in London, 1874. 2s.
24. Instructions in the Use of Meteorological Instruments. 2s. 6d.
25. Quarterly Weather Report for 1874. Parts I., II., and IV. 5s. each. Part III. 5s. 9d.
26. Report for 1874. 6d.
27. Charts of Meteorological Data for the Nine 10° Squares of the Atlantic which lie between 20° N. and 10° S., and extend from 10° to 40° W., with accompanying Remarks, ending with Remarks on the Best Routes across the Equator. 23s.

No.

28. Contribution to our Knowledge of the Meteorology of Japan.—By Staff-Commander Thomas H. Tizard, H.M.S. "Challenger." 1s.
29. Report for 1875. 4d.
30. Quarterly Weather Report for 1875.—Parts I. to IV. 5s. each.
31. Report for 1876-7. 3s. 5d.
32. A Discussion of the Meteorology of the North Atlantic during August 1873, with 31 Synoptic Charts. 15s.
33. Quarterly Weather Report for 1876. Part I., 6s. Part II. (with Plates). (In the Press.)
34. Contributions to our Knowledge of the Meteorology of the Arctic Regions, Part I., 2s.; Part II., 10s.; Part III. 6s.
35. Report for 1877–8. 1s.
36. Report of the Proceedings of the Meteorological Congress at Rome, 1879. 1s. 6d.
37. Report on the Meteorology of Kerguelen Island. By the Rev. S. J. Perry, S.J., F.R.S. 3s.
38. Report for 1878–9. 5d.
39. Meteorological Observational Stations of the Second Order for the year 1879. 20s.
40. Aids in the Study and Forecast of Weather. By the Rev. W. Clement Ley, M.A. 1s.
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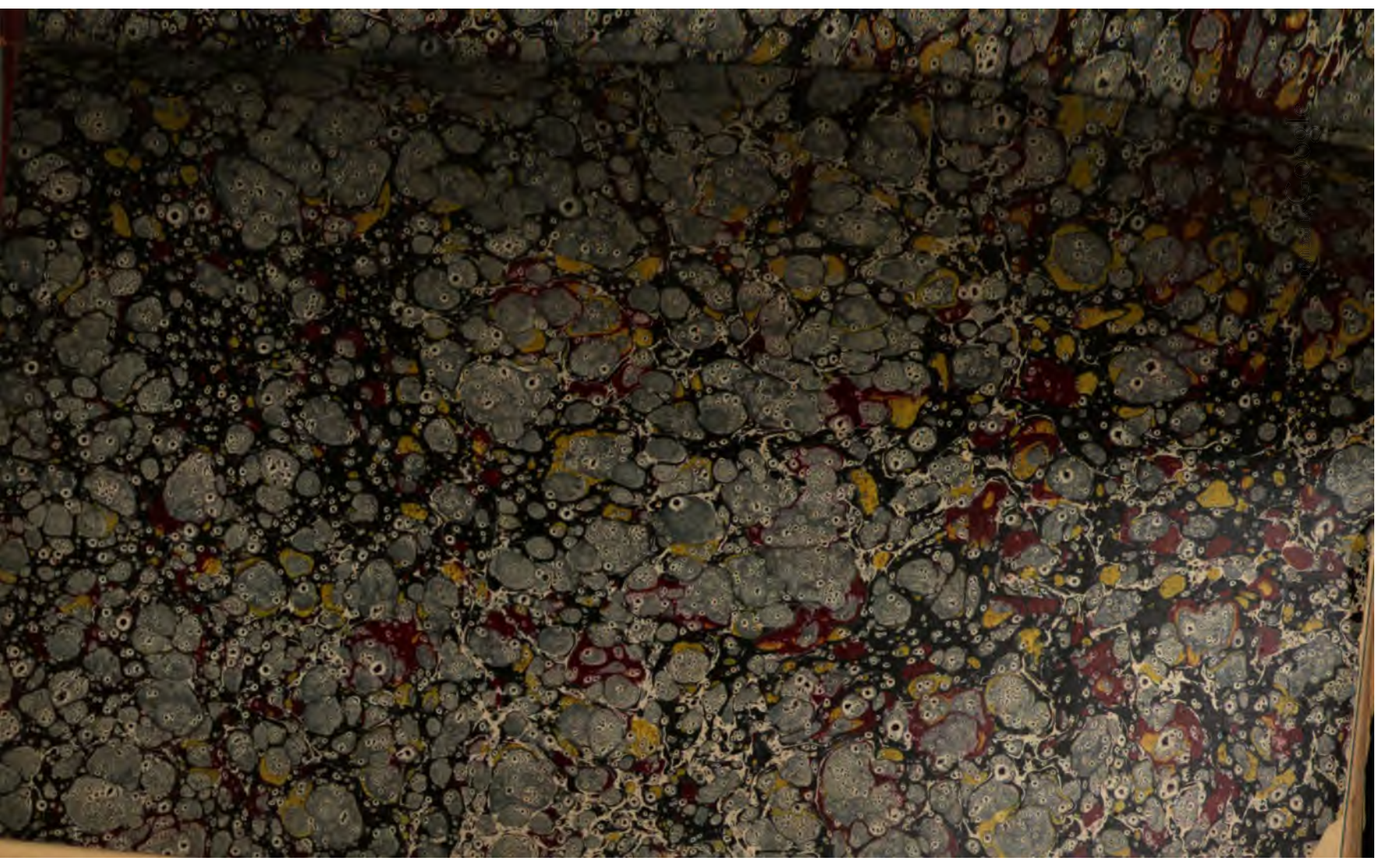

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